A Limnological Study of Ricks Pond and the Gulpha Creek Drainage in Garland County, Arkansas

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A LIMNOLOGICAL STUDY OF RICKS POND AND THE GULPHA CREEK DRAINAGE IN GARLAND COUNTY, ARKANSAS

An Interdisciplinary Study

Conducted for the

National Park Service
Southwest Regional Office
Santa Fe, New Mexico

Contributing Authors

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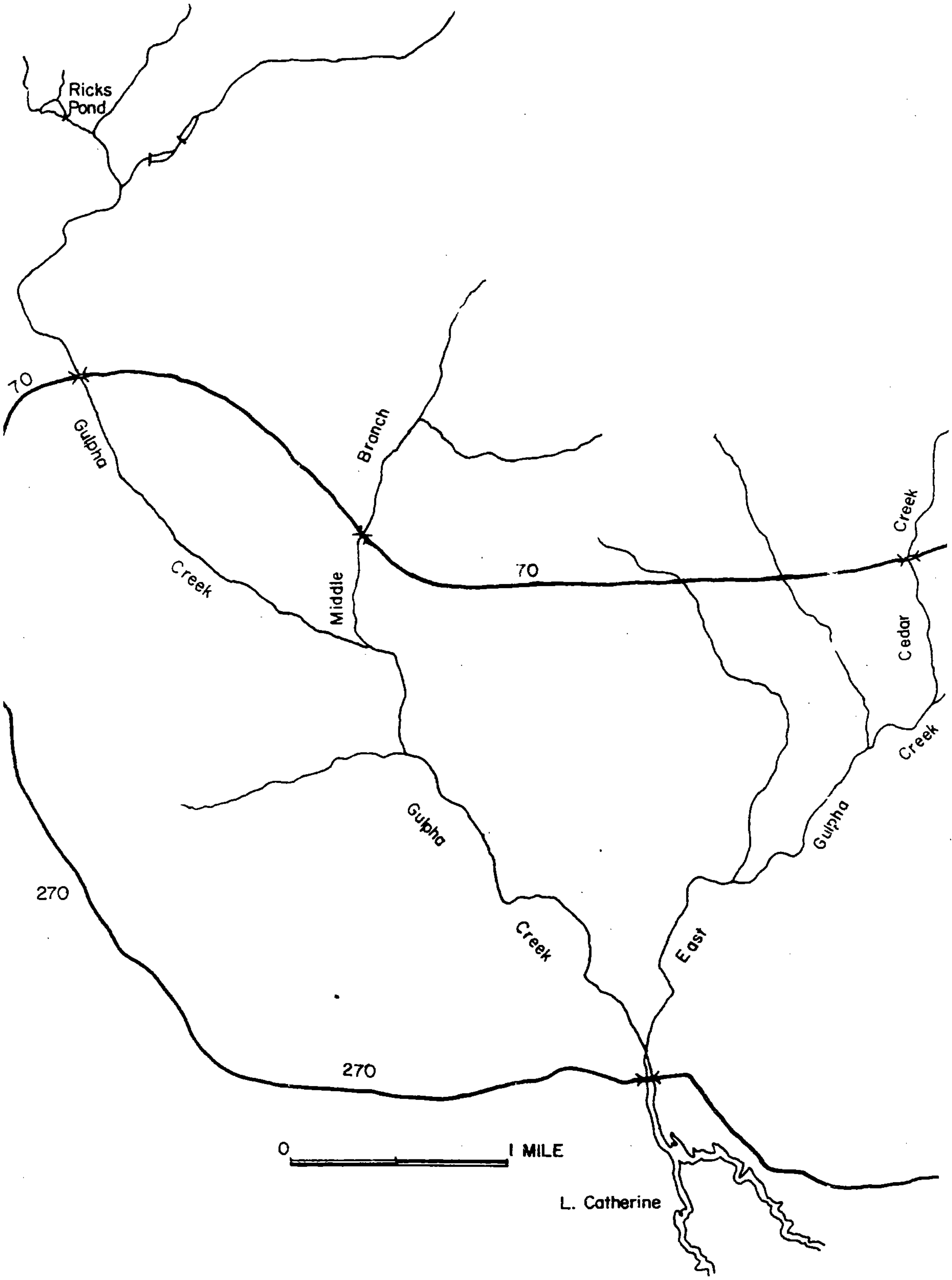
INTRODUCTION

Ricks Pond is a man-made impoundment located in the extreme headwaters of the Gulpha Creek drainage of Garland County, Arkansas (Figure 1). The pond and most of the main Gulpha Creek (comprising approximately five square miles of the watershed) lie within the city limits of the city of Hot Springs National Park. Only Ricks Pond and portions of two square miles of the upper watershed of Gulpha Creek are presently included in the National Park itself (portions of this region are still being acquired by the National Park Service).

The Gulpha Creek watershed is relatively small (approximately 48 square miles) and lies entirely within Garland County. The headwaters of the main creek are spring-fed tributaries largely within the northeastern portion of the city of Hot Springs. Two of these unnamed small tributaries flow into Ricks Pond. Middle Branch and East Gulpha Creek are the major downstream tributaries feeding into Gulpha Creek (Figure 1). Of these, the upper portion of East Gulpha Creek (including its tributary, Cedar Creek) became intermittent by mid-summer, whereas Middle Branch continued to have a good permanent flow. Gulpha Creek eventually flows into Lake Catherine, a large impoundment of the Ouachita River.

Gulpha Creek is typical of many small streams in the Ouachita Mountains of Arkansas, having the pool-riffle type of development, with small volume but permanent flow during the normal low flow period in July and August. Pools in the upper portion of Gulpha Creek had an average width of 2.0 meters and an average maximum depth of 1.0 meter. In the lower half of the drainage, pools averaged 4.0 meters in width and 1.6 meters in maximum depth. Bottom types consisted mainly of bedrock, rubble, and gravel throughout

Figure 1 - Map of Ricks Pond and the Gulpha Creek drainage study area.



the drainage.

Ricks Pond was impounded more than 40 years ago by constructing a cemented rock dam six meters high across Gulpha Creek (Plate I). There is a drain valve at the bottom of the dam, and the pond was drained and restocked with fish most recently in the mid-1960's by its former owners. The pond has a total surface area of 9,968 m^2 (approximately 1.0 hectare or 2.46 acres), a total volume of approximately 13,767 m^3, a maximum depth of 3.0 m, a mean depth of 1.38 m, and a shoreline development index of 1.23 (morphometric parameters determined by methods of Lind, 1974). Figure 2 is a map of Ricks Pond showing depth contours for depths of one, two, and three meters. The area of each depth contour is also given. Plates II-IV are photographs of Ricks Pond from three different vantage points.

The objectives of the present limnological study of Ricks Pond and the Gulpha Creek drainage were: (1) to characterize the existing water quality conditions; (2) to inventory the phytoplankton, periphyton, higher aquatic vegetation, zooplankton, benthos, and fishes and determine their distributional patterns; and (3) to make recommendations for the establishment of an appropriate put-and-take fishery in Ricks Pond.

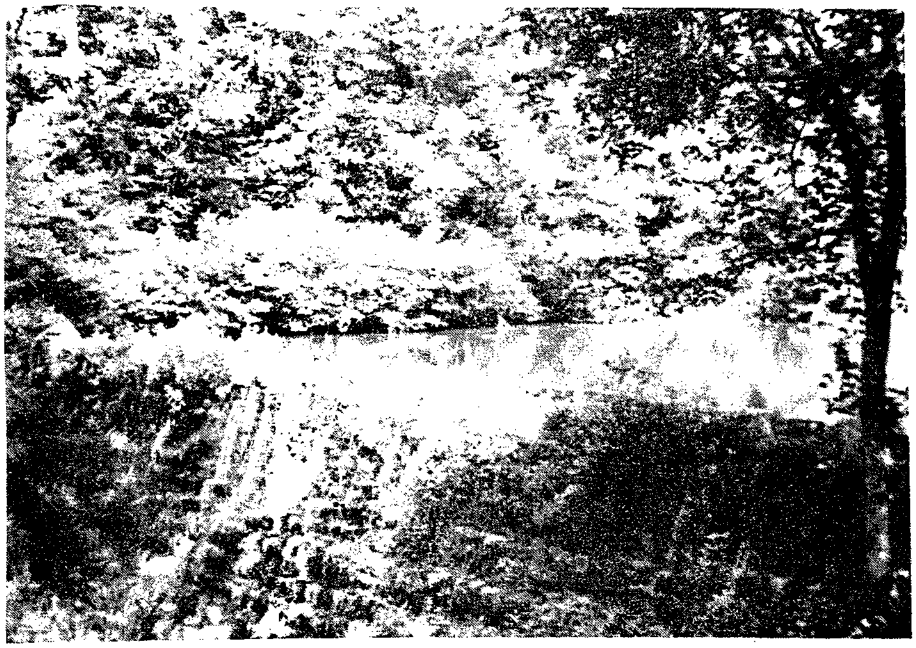


Plate I - The Ricks Pond dam.

Plate II - View of Ricks Pond from atop the dam
(boathouse is at left).

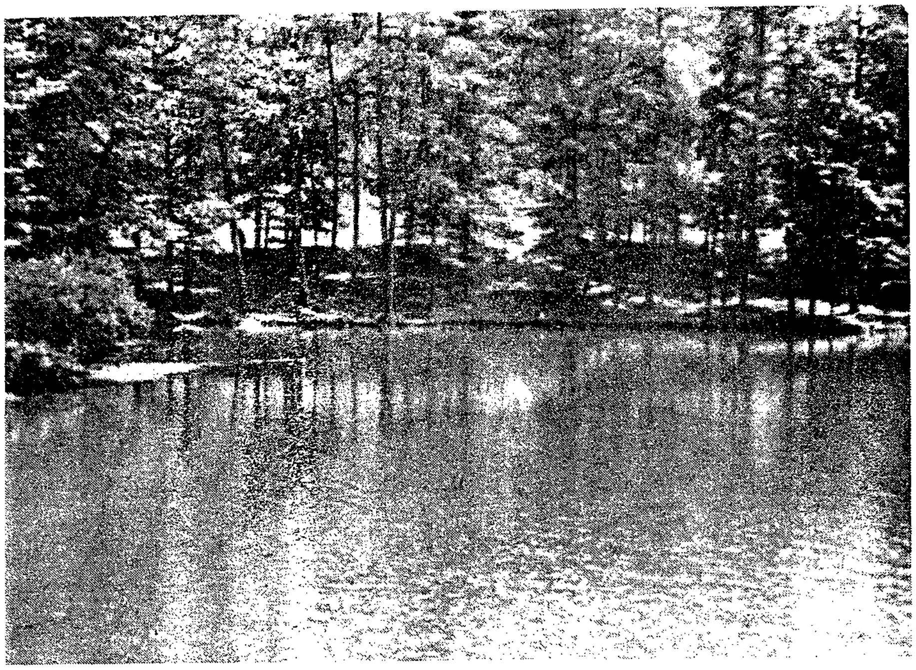
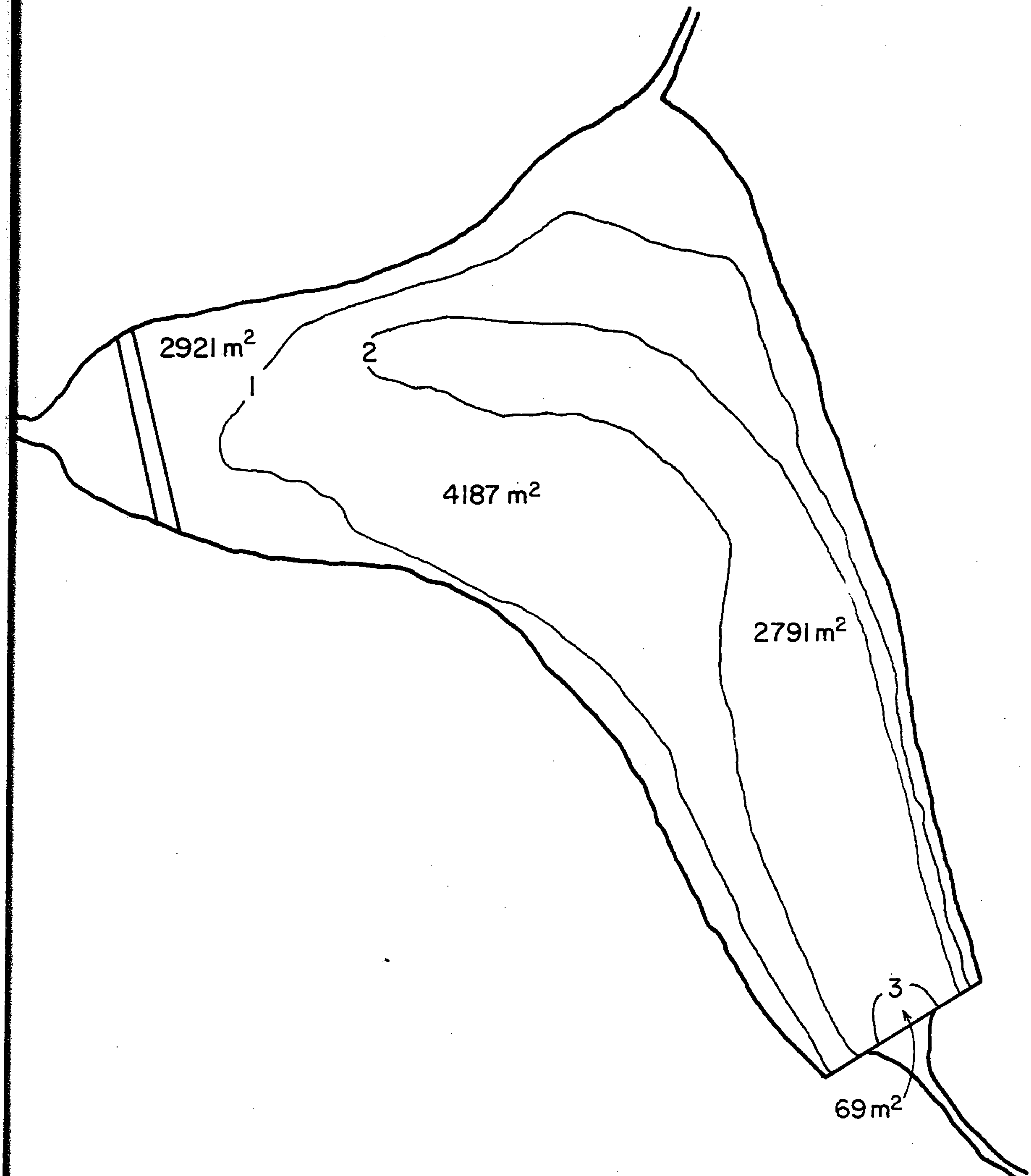


Plate III - View of Ricks Pond from south bank near boathouse. Manhole in north cove is evident at left-center.

Plate IV - View of Ricks Pond from near north end of foot bridge.

Figure 2 - Map of Ricks Pond showing depth contours and their areas.



WATER QUALITY

METHODS

A survey of pertinent water quality parameters of Ricks Pond and the immediate Gulpha Creek drainage was conducted to establish the general baseline patterns of water quality during the low-flow period (late June through early August, 1978). Water samples were taken from 10 stations to determine input and output characteristics above and below Ricks Pond (Figure 3). Four of the stations were in Ricks Pond (Figure 4), three stations were in the two upstream tributaries, and three stations were along Gulpha Creek, downstream from the Ricks Pond dam.

The water quality study included the identification and concentration determination of various chemical species, the determination of selected physical parameters, and bacteriological measurements of total coliform and fecal coliform concentrations. The following water quality parameters were determined: temperature, dissolved oxygen, specific conductance, pH, turbidity, alkalinety, ammonia nitrogen, total Kjeldahl nitrogen, nitrate nitrogen, ortho phosphate phosphorus, total phosphorus, total organic carbon, silica, sulfate, chloride, fluoride, sodium, potassium, calcium, iron, manganese, magnesium, and zinc. Water samples were collected at the 10 stations and field observations were made on 27 June 1978, 18 July 1978, and 03 August 1978.

All water quality parameters were determined using methods described in Standard Methods for the Examination of Water and Wastewater (13th edition, 1971), with the following exceptions: Temperature and dissolved oxygen were measured with a Yellow Springs

Figure 3 - Map of the study area showing the location of the 10 sampling stations for water quality.

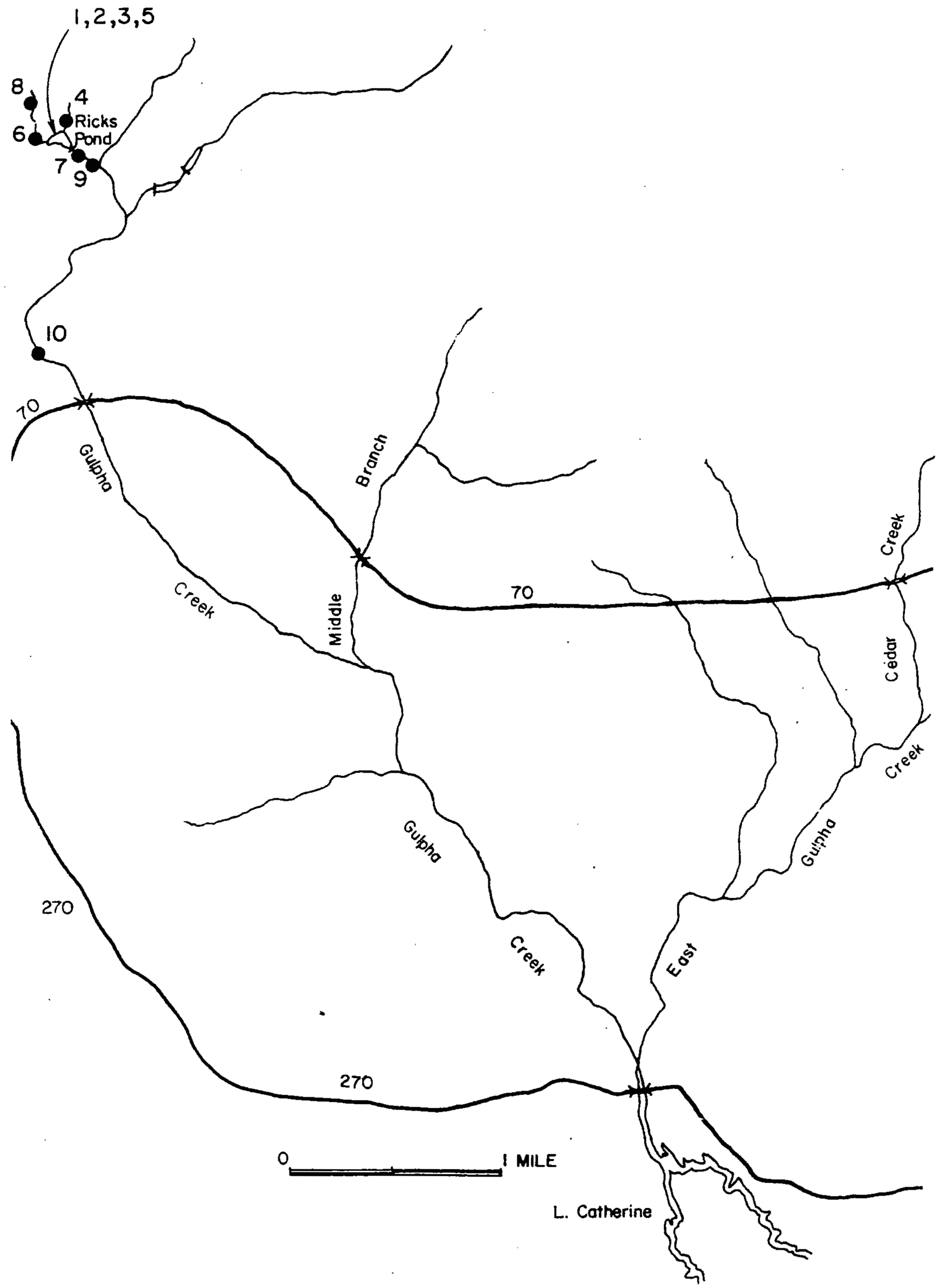
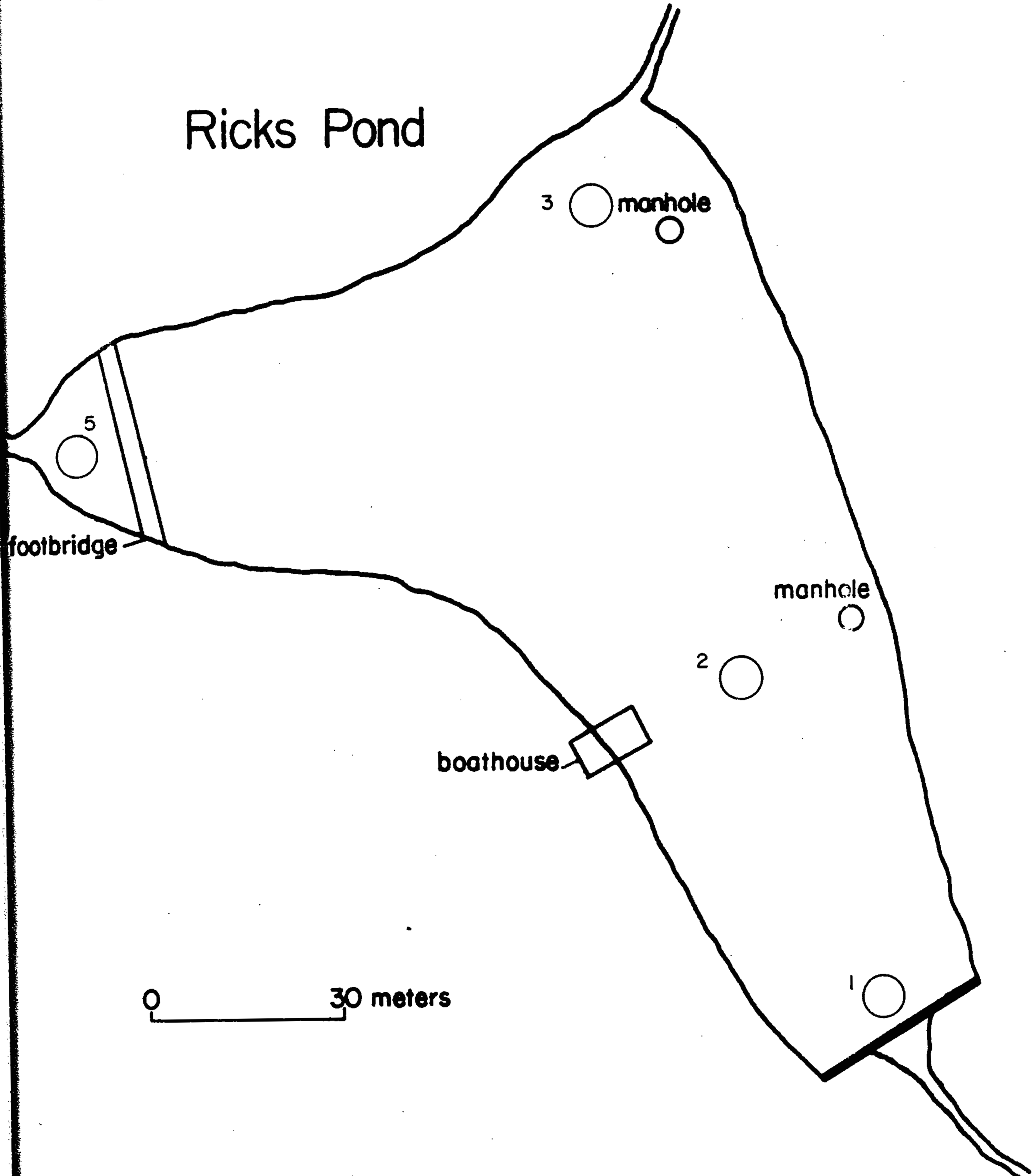


Figure 4 - The water quality sampling stations in Ricks Pond.



dissolved oxygen analyzer. This instrument was standardized for dissolved oxygen using the Winkler method. Temperature was calibrated with a NBS thermometer. Specific conductance was measured with a Yellow Springs SCT meter. It should be noted that the specific conductance values presented were not temperature corrected. The value reported represents the specific conductance of the sample at the temperature of the sample. Ammonia nitrogen, chloride, and fluoride levels were measured with Orion specific ion electrodes under conditions recommended by the manufacturer.

RESULTS AND DISCUSSION

The results of the June, July, and August 1978, water quality samples are presented in Tables 1-6. The laboratory analysis of samples taken from Ricks Pond and the adjacent drainages indicates that the stream and pond system are typical of other stream systems throughout this section of the Ouachita Mountains. The predominant anion present in the system was the bicarbonate ion, with calcium being the predominant cation. The presence of moderate amounts of iron probably reflects particulate iron present as iron oxide particles either suspended in the water or attached to plankton. No distinction was made between dissolved and particulate iron.

Ricks Pond was thermally stratified on all three sampling dates (Tables 1, 3, and 5). Although thermal gradients were relatively small, stratification was sufficient to allow an oxygen deficient zone to develop below a depth of one meter. Consequently, a considerable amount of water in the pond can be expected to be anoxic during the summer period. This anoxic zone probably accumulated reduced species such as iron, manganese, and possibly hydrogen sulfide. It is likely that mixing and flushing of the pond would

Table 1.- Temperature, dissolved oxygen, and specific conductance for the 10 water quality sampling stations for 27 June 1978. Stations 1, 2, 3, and 5 are in Ricks Pond. The depth profiles for these parameters are given for stations 1 and 2 in the pond.

STATION NO.	Depth (m)	TEMP. (°C)	D. O. (ppm)	SP. COND. (umhos/cm)
1	0	30.9	7.9	98
	0.5	29.0	7.7	98
	1.0	28.5	8.0	96
	1.5	26.5	5.6	96
	2.0	23.8	7.3	102
	2.5	20.5	0.1	240
2	0	29.4	7.7	107
	0.5	28.8	7.9	100
	1.0	27.8	7.0	100
	1.5	26.3	5.2	107
3	0	33.3	7.8	111
4	0	25.2	4.2	73
5	0	30.5	7.2	138
	0.5	28.0	7.2	--
6	0	24.9	5.6	149
7	0	31.4	6.3	150
8	0	24.5	6.3	88
9	0	28.3	4.5	130
10	0	31.5	6.4	222

Table 2.- Water quality data (excluding temperature, dissolved oxygen, and specific conductance) for the 10 sampling stations for 27 June 1978 (samples for the bacterial counts were taken on 11 July 1978).

	STATION NO.									
	1	2	3	4	5	6	7	8	9	10
pH	7.1	7.1	7.3	6.3	7.1	6.7	7.3	6.0	7.2	8.1
Alkalinity (ppm)	43	40	49	31	24	33	38	15	40	88
Calcium (ppm)	14.3	14.6	14.2	9.0	14.2	14.7	14.6	5.6	15.0	31.0
Magnesium (ppm)	.9	.3	.3	.5	.8	.8	.8	.4	.8	1.5
Sodium (ppm)	1.6	1.5	1.5	1.0	1.6	1.7	1.6	2.1	1.6	1.5
Potassium (ppm)	.5	.5	.5	.4	.5	.5	.5	.5	.6	.7
Iron (ppm)	1.1	1.0	.9	1.0	1.2	.3	.9	.2	1.0	.2
Manganese (ppm)	.0	.0	.0	.0	.0	.0	.1	.0	.1	.0
Chloride (ppm)	4.6	3.2	4.3	.9	4.6	3.4	3.3	3.6	3.8	4.4
Fluoride (ppm)	.08	.07	.07	.05	.07	.07	.07	.04	.08	.10
Sulfate (ppm)	8.5	7.3	8.2	6.1	8.2	9.9	9.0	11.5	7.7	9.9
Silica (ppm)	4.5	4.3	4.0	6.5	4.5	7.1	4.5	6.4	4.3	6.4
Ammonia Nitrogen (ppm)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Nitrate Nitrogen (ppm)	.00	.00	.00	.03	.00	.08	.01	.13	.02	.06
TKN (ppm)	.2	.6	.4	.3	.6	.2	.5	.3	.4	.2
Total P (ppm)	.019	.019	.025	.018	.028	.015	.026	.014	.032	.028
Ortho Phosphate P (ppm)	.003	.004	.004	.009	.007	.007	.007	.002	.011	.022
TOC (ppm)	3.1	3.1	3.5	2.5	3.8	2.0	3.3	1.5	3.6	2.6
**Total Coliform (cells/100ml)	2100	1100	2400	6900	2700	15100	29000	1700	1400	9900
**Fecal Coliform (cells/100 ml)	0	3	0	0	0	0	0	0	0	0
Turbidity (NTU)	3.3	2.3	2.1	2.1	2.9	1.1	1.7	1.6	2.5	1.7
Zinc (ppm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Samples taken on July 11, 1978

Table 3.- Temperature, dissolved oxygen, and specific conductance for the 10 water quality sampling stations for 18 July 1978.

STATION NO.	Depth (m)	TEMP. (°C)	D.O. (ppm)	SP. COND. (umhos/cm)
1	0	27.6	10.1	198
2	0	27.0	9.1	190
3	0	27.5	9.8	188
4	0	26.4	5.4	67
5	0	27.1	9.5	300
6	0	22.4	6.3	330
7	0	27.0	7.0	91
8	0	20.4	7.4	50
9	0	25.7	3.3	115
10	0	24.0	8.2	211

Table 4.- Water quality data (excluding temperature, dissolved oxygen, and specific conductance) for the 10 sampling stations for 18 July 1978.

	STATION NO.									
	1	2	3	4	5	6	7	8	9	10
pH										
Alkalinity (ppm)	42	41	37	25	40	37	41	10	44	84
Calcium (ppm)	15.9	15.6	15.6	9.3	15.6	15.0	16.4	4.3	16.4	32.6
Magnesium (ppm)	1.0	1.0	1.0	.6	1.0	1.0	1.1	.6	1.1	2.0
Sodium (ppm)	1.3	1.3	1.3	.8	1.3	1.3	1.3	1.7	1.4	1.2
Potassium (ppm)	.6	.5	.5	.4	.6	.5	.6	.5	.6	.6
Iron (ppm)	1.1	1.1	1.1	1.2	0.9	1.2	0.8	0.2	1.3	0.2
Manganese (ppm)	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.1
Chloride (ppm)	4.8	5.0	4.8	4.3	4.9	4.5	5.4	5.0	5.1	4.5
Fluoride (ppm)	.09	.08	.08	.06	.08	.07	.07	.05	.09	.10
Sulfate (ppm)	5.8	6.1	6.2	4.3	7.4	8.5	6.4	11.3	4.9	9.0
Silica (ppm)	7.1	7.0	7.3	9.2	7.3	9.2	7.4	9.3	6.9	8.4
Ammonia Nitrogen (ppm)	.00	.04	.02	.02	.00	.00	.01	.00	.04	.01
Nitrate Nitrogen (ppm)	.00	.00	.00	.04	.00	.06	.07	.10	.08	.12
TKN (ppm)	1.1	.8	1.1	.2	.7	.2	.8	.1	.3	.2
Total P (ppm)	.059	.036	.054	.028	.036	.021	.48	.012	.042	.025
Ortho Phosphate (ppm)	.004	.002	.002	.008	.002	.006	.001	.003	.005	.014
TOC (ppm)	--	--	6.7	3.3	5.5	2.5	6.2	2.0	--	2.6
Total Coliform (cells/100ml)										
Fecal Coliform (cells/100 ml)										
Turbidity (NTU)	7.0	6.9	7.4	4.0	6.6	2.0	4.2	1.1	7.7	1.3
Zinc (ppm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1

Table 5.- Temperature, dissolved oxygen, and specific conductance for the 10 water quality sampling stations for 3 August 1978. The depth profiles for these parameters are given for stations 1, 2, and 3 in Ricks Pond.

STATION NO.	Depth (m)	TEMP. (°C)	D.O. (ppm)	SP.COND. (umhos/cm)
1	0	29.0	10.2	112
	0.5	27.5	9.9	112
	1.0	27.0	7.5	112
	1.5	25.6	0.6	120
	2.0	24.8	0.5	196
	2.5	22.9	0.4	278
2	0	28.8	11.4	112
	0.5	27.5	11.1	111
	1.0	26.0	5.4	110
	1.5	26.0	0.6	113
	2.0	22.9	0.6	179
3	0	28.9	11.2	113
	0.5	28.1	11.5	112
	1.0	27.0	6.7	110
	1.5	26.3	5.9	110
5	0	28.9	10.4	112
6	0	25.3	7.3	107
7	0	29.0	7.1	117
8	0	23.0	8.4	71
9	0	27.7	5.9	117
10	0.	28.2	7.1	207

Table 6.- Water quality data (excluding temperature, dissolved oxygen, and specific conductance) for the 10 sampling stations for 3 August 1978.

	STATION NO.									
	1	2	3	4	5	6	7	8	9	10
pH	7.1	7.2	7.5	7.4	7.2	7.0	7.5	7.7	7.6	7.4
Alkalinity (ppm)	42	41	40	28	40	44	43	19	43	89
Calcium (ppm)	15.6	15.9	16.2	11.1	16.2	16.5	16.5	8.7	18.0	32.5
Magnesium (ppm)	1.0	1.0	1.0	0.7	1.0	1.0	1.1	0.7	1.1	2.0
Sodium (ppm)	1.5	1.5	1.5	0.9	1.5	1.6	1.5	1.8	1.5	1.3
Potassium (ppm)	0.6	0.6	0.6	0.4	0.6	0.6	0.6	0.5	0.7	0.6
Iron (ppm)	1.2	.9	.9	2.0	1.1	1.1	1.4	1	1.1	.2
Manganese (ppm)	0.1	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.2	0.0
Chloride (ppm)	2.7	2.9	2.5	1.4	2.7	2.7	2.7	2.2	3.0	2.6
Fluoride (ppm)	.07	.08	.07	.06	.08	.07	.08	.05	.08	.11
Sulfate (ppm)	5.0	5.3	5.6	3.1	5.0	7.6	5.0	8.8	5.0	7.2
Silica (ppm)	7.3	6.8	7.4	7.9	7.4	8.0	8.1	9.1	8.0	8.3
Ammonia Nitrogen (ppm)	.03	.03	.08	.00	.00	.00	.06	.00	.02	.00
Nitrate Nitrogen (ppm)	.01	.00	.01	.03	.01	.08	.01	.11	.08	.05
TKN (ppm)	1.1	1.0	1.5	0.4	0.8	0.4	0.6	0.6	0.8	0.7
Total P (ppm)	.031	.037	.101	.028	.042	.013	.035	.011	.026	.019
Ortho Phosphate P (ppm)	.001	.002	.007	.009	.002	.005	.006	.003	.008	.012
TOC (ppm)										
Total Coliform (cells/100ml)	670	1050	1550	5800	7800	2400	2200	1500	300	4900
Fecal Coliform (cells/100 ml)	140	110	0	0	710	161	40	50	35	11
Turbidity (NTU)	1.3	2.1	1.7	5.8	3.7	0.7	3.8	2.6	1.8	.7
Zinc (ppm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

occur after heavy rains. Observations on other small lakes in central Arkansas have shown that even after flushing, the anoxic zone often becomes reestablished during the summer period (unpublished data, Dr. Joe Nix). The existence of anoxic zones in small lakes should be viewed with caution, because oxygen stress periods for fishes could result after or during periods of mixing.

Total phosphorus concentrations along with the values obtained for total organic carbon (TOC, Tables 2, 4, and 6) indicate that Ricks Pond is moderately productive. Low values of nitrate nitrogen, ammonia nitrogen, and total Kjeldahl nitrogen (TKN) suggest that the productivity of the pond ecosystem may be limited by the nitrogen species. If this is the case, the introduction of nitrogen (such as in the form of commercial fish food) could result in an increased level of productivity, possibly to the point of becoming over productive.

Turbidity values along with qualitative observations on water color support the idea that the pond is relatively productive. On August 3, and September 10, 1978, Ricks Pond was very brown in color. Such color often indicates a die-off of large quantities of algae.

Total and fecal coliform bacteria counts indicate that the stream system and the pond are typical of other streams which drain similar terrain. Total coliform analysis often reflects the presence of soil bacteria and cannot be used as a sole indicator of fecal matter. The fecal coliform measure is a much better indicator of the presence of fecal matter, but makes no distinction between fecal matter of human origin and that from domestic or wild animals. The concentration of fecal coliform bacteria was low and indicates that there was no direct input of excessive amounts of fecal matter into the system during the present study. However the fecal coliform content of Ricks Pond would probably increase during and after periods of heavy rain. Such increases are usually due to fecal matter from domestic and wild animals in the vicinity of the stream system. There were no extensive grazing lands in the upper Gulpha Creek watershed, and this increase in fecal coliforms following a rain would probably be minimal.

Of particular concern is the sewer line which runs through Ricks Pond, with two manholes emerging from the surface of the pond (Plate III). The problems that this situation presents are dealt with elsewhere in this report (see Recommendations section).

The water quality data taken at Station 10 (Gulpha Creek at the National Park Campground in Gulpha Gorge) indicate that the addition of considerable amounts of dissolved species occurred between Ricks Pond and the campground. Although it is likely that the addition of these components is of natural origin (changes in rock types, etc.), this should be studied further to determine if there is anthropogenic addition to the stream.

PHYTOPLANKTON AND PERIPHYTON

METHODS

Phytoplankton

Integrated phytoplankton samples were collected at 5 sites in Rick's Pond by bottom to surface vertical hauls with a 20 mesh plankton net (Figures 5 and 6). Samples were immediately fixed with M_3 fixative (Meyer, 1971). In the laboratory sample concentrations were adjusted to 1 ml concentrate equivalent to 1 liter lake water.

Subsamples of the concentrates were used for taxonomic verification. Additional subsamples were adjusted to 1 ml equivalent to 0.01 liter. The diluted subsamples were enumerated in a Sedgwick-Rafer counting chamber under 200x magnification with an Olympus FHT phase-contrast microscope. Enumeration counts were corrected to organisms per liter and relative density.

Periphyton

At least 3 representative stream bed substrate samples were placed in double or triple polyethylene bags. A small quantity of stream water was included to adjust the M_3 fixative final concentration to ca. 2%. The enclosed natural substrates were transported to the laboratory for further processing.

Epilithic periphyton was removed from a combined surface area of ca. 5 cm^2 from three substrate samples. The removed periphyton was suspended in 5 ml of distilled water containing 2% M_3 fixative.

Periphyton samples were gently randomized by repeated inversions of the specimen vials. Small subsamples were placed on microscope slides for identification and enumeration. Three hundred (300) organisms were identified and enumerated by the standard strip-

Figure 5 - Map of the study area showing the sampling sties for phytoplankton, periphyton, zooplankton, and benthos.

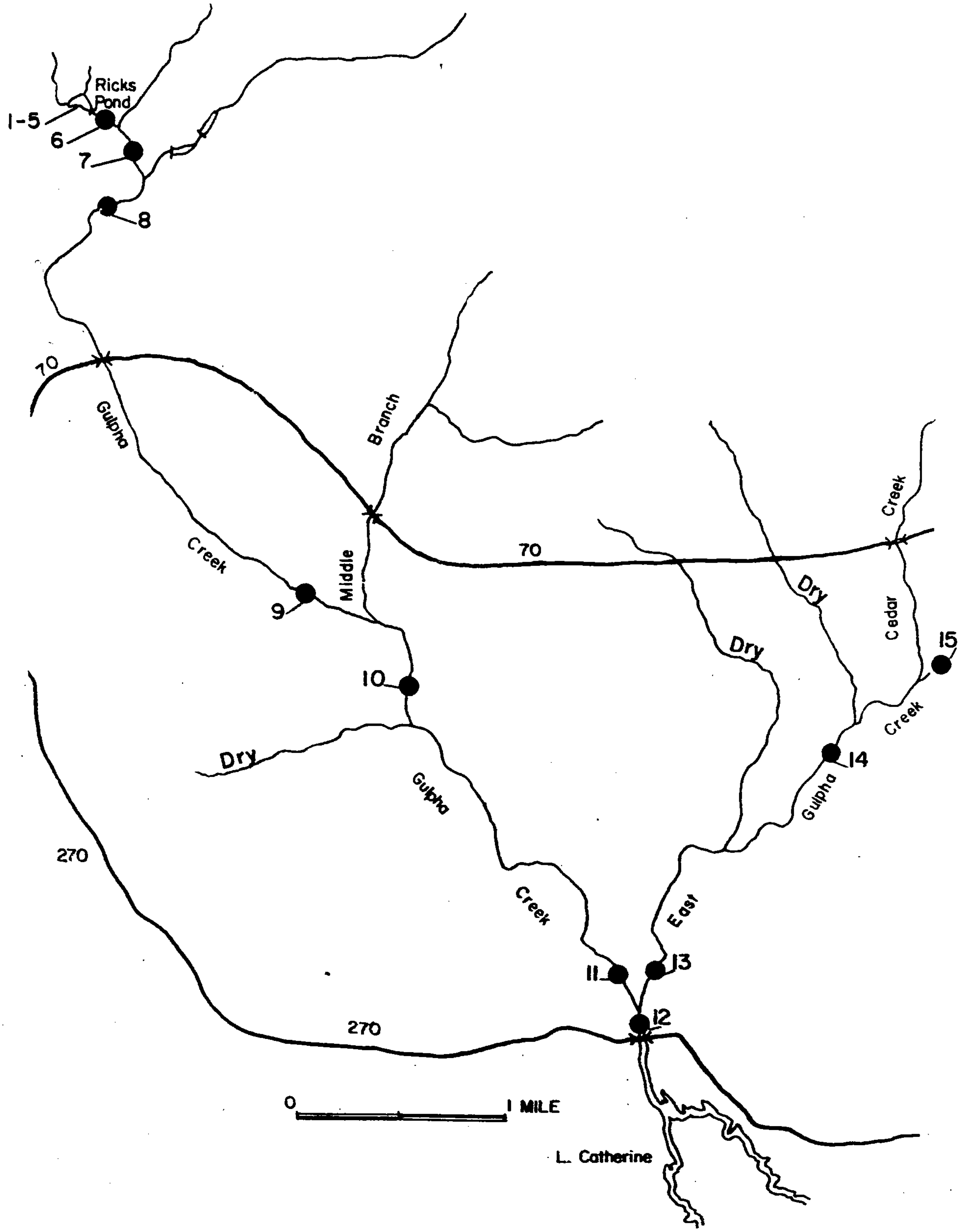
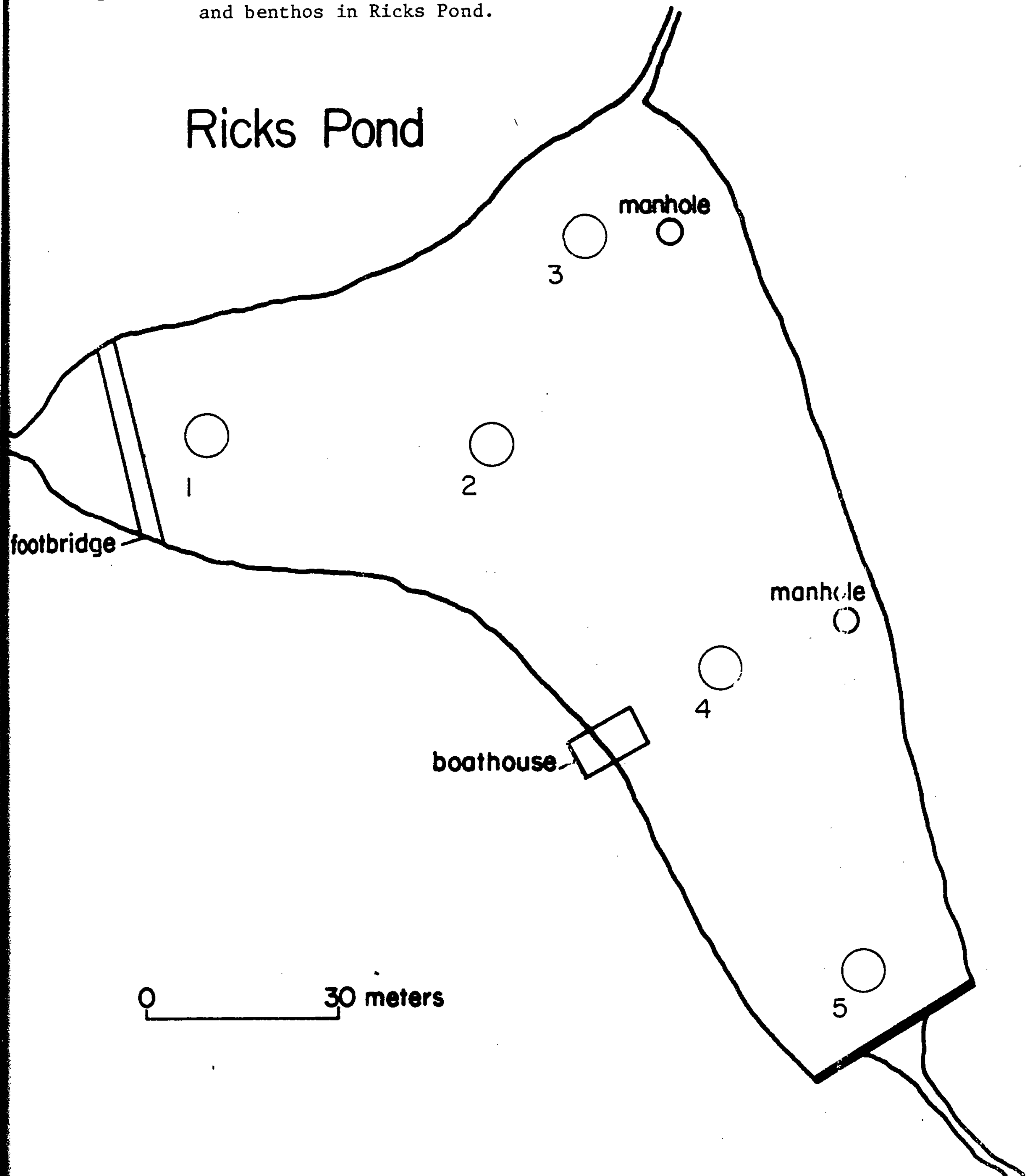


Figure 6 - Sampling sites for phytoplankton, periphyton, zooplankton, and benthos in Ricks Pond.



count method. The organisms were enumerated at 500x magnification with a Zeiss Photoscope II containing phase-contrast optics. Data from these counts were used to calculate relative density of periphytic organisms.

RESULTS

The data for the algae samples from the Ricks Pond drainage system are presented in Tables 7-12. These data include phytoplankton densities for the five sites in Ricks Pond and relative densities for the periphyton from 10 sites along the drainage system. The phytoplankton are reported in organisms per liter by species when unquestionable identification could be made. If positive specific identification was not possible, only the generic epithet is given. The data are recorded as standing crop, but may be readily converted to relative density to reflect community structure.

The epilithic periphyton are reported in terms of relative density, because there is no adequate method for collecting absolute data from highly irregular surfaces. Because of these analytical limitations, the size of the standing crop cannot be estimated. The data provided reflect the relative abundance of each genus. A summary table is also provided for each site which indicates the gross community structure.

Table 7 - Phytoplankton enumeration data from Ricks Pond for 11 July 1978

Taxon	Organisms per liter Site 1	Site 2	Site 3	Site 4	Site 5
Cyanophyceae					
Anabaena sp.	153,400	105,200	145,600	119,200	82,000
Oscillatoria spp.	10,400	100,800	14,800	265,200	163,600
Euglenophyceae					
Euglena variabilis	600	800	1,100	1,100	900
Euglena ehrenbergii	200		300	900	1,300
Euglena spirogyra	100			100	100
Euglena sp.			100	500	
Lepocinclis ovum	300	100	100	200	200
Phacus suecia	100		100		
Trachelomonas hispida	100			400	800
Trachelomonas mirabilis	400				
Trachelomonas rugosa	100		100		
Trachelomonas volvocina	300	100	100	100	
Pyrrhophyceae					
Peridinium spp.	14,400	9,200	6,800	11,200	5,600
Ceratium hirundinella	4,800	800	2,000	4,000	2,400
Cryptophyceae					
Cryptomonas sp.	2,400	6,000	2,000	100	
Chrysophyceae					
Dinobryon bavaricum	300		200	100	
Mallomonas sp.					
Conjugatophyceae					
Closterium sp.		100			
Spirogyra sp.	200				
Euastrum sp.	100				
Chlorophyceae					
Chlamydomonas sp.	100	100	100		
Gloeocystis botryoides				100	
Sphaerocystis schroeteri		100			
Elaktothrix viridis					
Crucigenia irregularis					
Ankistrodesmus falcalus	100		100	100	
Ulothrix sp.	500				
Pediastrum simplex		100	200		

Table 7 (Continued)

Taxon	Site 1	Site 2	Site 3	Site 4	Site 5
Bacillariophyceae					
Attheya zachariasi					
Cyclotella	4,200	1,000	1,200	600	
Melosira varians	1,600	800		6,000	
Melosira granulata	55,600	9,200	14,400	15,200	
Achnanthes	200				
Fragilaria	100	100	100		
Frustulia		100	300		
Navicula	10,400	[illegible],200	2,400	100	400
Pinnularia	100		100		
Rhopolodia	2,000	100	100		
Surirella				100	
Synedra	31,200	8,000	5,400	10,000	5,600
Cymbella	100		100		
Eunotia			300		
TOTAL	294,000	247,000	199,000	43[illegible],400	262,900

SUMMARY

	Site 1	Site 2	Site 3	Site 4	Site 5
Cyanophyceae	163,800	206,000	160,400	384,400	245,600
Eugleuophyceae	[illegible],300	1,000	1,900	3,300	3,300
Pyrrhophyceae	19,200	10,000	8,800	15,200	8,000
Cryptophyceae	2,400	6,000	2,000	100	
Chrysophyceae	[illegible]00		200	100	
Conjugatophyceae	300	100			
Chlorophyceae	700	300	400	200	200
Bacillariophyceae	105,500	23,600	25,300	32,100	6,000

Table 8 - Relative density (%) of phytoplankton from Ricks Pond, (Sites 1-5) - 11 July 1978.

Taxon	Relative Density (%)				
	Site 1	Site 2	Site 3	Site 4	Site 5
Cyanophyceae					
Anabaena sp.	52	43	73	27	31
Oscillatoria spp.	4	41	7	61	62
Euglenophyceae					
Euglena variabilis	< *	<	1	<	<
Euglena ehrenbergii	<		<	<	<
Euglena spirogyra	<			<	<
Euglena sp.			<	<	
Leopcinclis ovum	<	<	<	<	<
Phacus suecia	<		<		
Trachelomonas hispida	<			<	<
Trachelomonas mirabilis	<				
Trachelomonas rugosa	<		<		
Trachelomonas volvocina	<	<	<	<	
Pyrrhophyceae					
Peridinium spp.	5	4	3	3	2
Ceratium hirundinella	2	<	1	1	1
Cryptophyceae					
Cryptomonas sp.	1	2	1	<	
Chrysophyceae					
Dinobryon bavaricum	<		<	<	
Mallomonas sp.					
Conjugatophyceae					
Closterium sp.		<			
Spirogyra sp.	<				
Euastrum sp.	<				
Chlorophyceae					
Chlamydomonas sp.	<	<	<	<	
Gloeocystis botryoides					
Sphaerocystis schroeteri		<			
Elaktothrix viridis					
Crucigenia irregularis					
Ankistrodesmus falcalus	<		<	<	
Ulothrix sp.	<				
Pediastrum simplex		<	<		

Table 8 (Continued)

Taxon	Site 1	Site 2	Site 3	Site 4	Site 5
Bacillariophyceae					
Attheya zachariasi					
Cyclotella	1	<	1	<	
Melosira varians	1	<		1	
Melosira granulata	19	4	7	3	
Achnanthes	<				
Fragilaria	<	<	<		
Frustulia		<	<		
Navicula	4	2	1	<	<
Pinnularia	<	<		<	
Rhopolodia	1	<	<		
Surirella				<	
Synedra	11	3	3	2	2
Cymbella	<		<		
Eunotia			<		

SUMMARY

Cyanophyceae	56	83	81	88	93
Euglenophyceae	1	<	1	1	1
Pyrrhophyceae	7	4	4	3	3
Cryptophyceae	1	2	1	<	
Chrysophyceae	<		<	<	
Conjugatophyceae	<	<			
Chlorophyceae	<	<	<	<	<
Bacillariophyceae	36	10	13	7	2

* < = <1%

Table 9 - Phytoplankton enumeration data from Ricks Pond for 3 August 1978

Taxon	Organisms per liter Site 1	Site 2	Site 3	Site 4	Site 5
Cyanophyceae					
Anabaeae sp.	19,600	6,400	400	3,200	400
Oscillatoria spp.	2,400	14,400	2,000	6,800	1,400
Euglenophyceae					
Colacium vesiculosum	20,800	9,600	6,800	3,600	9,000
Euglena spp.	13,600	8,800	6,400	4,400	11,200
Phacus suecia		100			
Trachelomonas spp.	2,400	400	2,000	800	400
Pyrrhophyceae					
Ceratium hirundinella	8,400	2,000	400		
Peridinium spp.	48,400	5,600	6,400	3,200	2,000
Cryptophyceae					
Cryptomonas	1,000	1,200	1,200		800
Chrysophyceae					
Dinobryon divergens	100	100	1,600		
Chlorophyceae					
Gloeocystis botryoides		100			
Bacillariophyceae					
Cymbella	100				
Navicula	1,600				
Pinnularia				100	
TOTAL	118,400	48,700	27,200	22,100	25,800

Table 9 (Continued)

SUMMARY

	Site 1	Site 2	Site 3	Site 4	Site 5
Cyanophyceae	22,000	20,800	2,400	10,000	1,800
Euglenophyceae	36,800	18,900	15,200	8,800	21,200
Pyrrhophyceae	56,800	7,600	6,800	3,200	2,000
Cryptophyceae	1,000	1,200	1,200		800
Chrysophyceae	100	100	1,600		
Chlorophyceae		100			
Bacillariophyceae	1,700			100	

Table 10 - Relative Density (%) of Phytoplankton from Ricks Pond, (Sites 1 - 5) - 3 August 1978.

Taxon	Relative Density (%) Site 1	Site 2	Site 3	Site 4	Site 5
Cyanophyceae					
Anabaeae sp.	17	13	1	14	2
Oscillatoria spp.	2	30	7	31	5
Euglenophyceae					
Coacium vesiculosum	18	20	25	16	37
Euglena spp.	11	18	24	20	43
Phacus suecia		< *			
Trachelomonas spp.	2	1	7	4	2
Pyrrhophyceae					
Ceratium hirundinella	7	4	1		
Peridinium spp.	41	11	24	14	8
Cryptophyceae					
Cryptomonas	1	2	4		3
Chrysophyceae					
Dinobryon divergens	<	<	6		
Chlorophyceae					
Gloeocystis botryoides		<			
Bacillariophyceae					
Cymbella	<				
Navicula	1				
Pinnularia				<	

Table 10(Continued)

SUMMARY

	Site 1	Site 2	Site 3	Site 4	Site 5
Cyanophyceae	19	43	9	45	7
Euglenophyceae	31	39	56	40	82
Pyrrhophyceae	48	16	25	14	8
Cryptophyceae	1	2	4		3
Chrysophyceae	<	<	6		
Chlorophyceae		<			
Bacillariophyceae	1			<	

*< = <1%

Table 11 - Relative density (%) of algae in the periphyton community (10 July 1978, Gulpha Creek samples).

SITE 6

Genus - Class	%
Lyngbya - Cyanophyceae	31
Navicula - Bacillariophyceae	16
Gomphonema - Bacillariophyceae	8
Synedra - Bacillariophyceae	7
Cyclotella - Bacillariophyceae	7
Achnanthes - Bacillariophyceae	6
Audouinella - Rhodophyceae	6
Melosira - Bacillariophyceae	5
Cymbella - Bacillariophyceae	3
Oscillatoria - Cyanophyceae	3
Synechocystis - Cyanophyceae	2
Nitzchia - Bacillariophyceae	2
Frustulia - Bacillariophyceae	1
Cocconeis - Bacillariophyceae	1
Eunotia - Bacillariophyceae	1
Oedogonium - Chlorophyceae	1

SUMMARY

Bacillariophyceae	57
Cyanophyceae	36
Rhodophyceae	6
Chlorophyceae	1

Table 11 (Continued)

SITE 7

Genus - Class	%
Anabaena - Cyanophyceae	80
Synedra - Bacillariophyceae	5
Navicula - Bacillariophyceae	4
Audouinella - Rhodophyceae	4
Lyngbya - Cyanophyceae	2
Oscillatoria - Cyanophyceae	2
Melosira - Bacillariophyceae	1
Surirella - Bacillariophyceae	1

SUMMARY

Cyanophyceae	84
Bacillariophyceae	12
Rhodophyceae	4

Table 11 (Continued)

SITE 8

Genus - Class	%
Tolypothrix - Cyanophyceae	76
Calothrix - Cyanophyceae	8
Gomontia - Chlorophyceae	7
Lyngbya - Cyanophyceae	6
Anabaena - Cyanophyceae	3

SUMMARY

Cyanophyceae	93
Chlorophyceae	7

Table 11 (Continued)

SITE 9

Genus - Class	%
Oedogonium - Chlorophyceae	68
Calothrix - Cyanophyceae	8
Nitzschia - Bacillariophyceae	6
Spirogyra - Conjugatophyceae	4
Tolypothrix - Cyanophyceae	3
Navicula - Bacillariophyceae	2
Cymbella - Bacillariophyceae	2
Rhopolodia - Bacillariophyceae	1
Melosira - Bacillariophyceae	1
Cocconeis - Bacillariophyceae	1
Surirella - Bacillariophyceae	1
Lyngbya - Cyanophyceae	1
Audouinella - Rhodophyceae	1

SUMMARY

Chlorophyceae	68
Bacillariophyceae	15
Cyanophyceae	12
Conjugatophyceae	4
Rhodophyceae	1

Table 11 (Continued)

SITE 10

Genus - Class	%
Stigeoclonium - Chlorophyceae	85
Lyngbya - Cyanophyceae	4
Melosira - Bacillariophyceae	2
Cyclotella - Bacillariophyceae	2
Cymbella - Bacillariophyceae	1
Cocconeis - Bacillariophyceae	1
Navicula - Bacillariophyceae	1
Anabaena - Cyanophyceae	1
Coleochaete - Chlorophyceae	1
Pandorina - Chlorophyceae	1

SUMMARY

Chlorophyceae	87
Bacillariophyceae	8
Cyanophyceae	5

Table 11 (Continued)

SITE 11

Genus - Class	%
Anabaena - Cyanophyceae	81
Oscillatoria - Cyanophyceae	13
Melosira - Bacillariophyceae	1
Cyclotella - Bacillariophyceae	1
Surirella - Bacillariophyceae	1
Euglena - Euglenophyceae	1
Trachelomonas - Euglenophyceae	1
Chantransia-stage - Rhodophyceae	1

SUMMARY

Cyanophyceae	94
Bacillariophyceae	3
Euglenophyceae	2
Rhodophyceae	1

Table 11(Continued)

SITE 12

Genus - Class	%
Aphanocapsa - Cyanophyceae	84
Oscillatoria - Cyanophyceae	10
Anabaena - Cyanophyceae	5
Gomontia - Chlorophyceae	1

SUMMARY

Cyanophyceae	99
Chlorophyceae	1

Table 11 (Continued)

SITE 13

Genus - Class	%
Rivularia - Cyanophyceae	96
Phormidium - Cyanophyceae	3
Gomontia - Chlorophyceae	1

SUMMARY

Cyanophyceae	99
Chlorophyceae	1

Table 11(Continued)

SITE 14

Genus - Class	%
Rivularia - Cyanophyceae	87
Phormidium - Cyanophyceae	13

SUMMARY

Cyanophyceae	100

Table 11 (Continued)

SITE 15

Genus - Class	%
Rivularia - Cyanophyceae	95
Phormidium - Cyanophyceae	4
Synedra - Bacillariophyceae	1

SUMMARY

Cyanophyceae	99
Bacillariophyceae	1

Table 12 - Taxonomic list of organisms associated with the periphyton community.

Chlorophyceae
- Coleochaete
- Gomontia
- Oedogonium
- Pandorina
- Stigeoclonium
- Ulothrix

Conjugatophyceae
- Spriogyra

Euglenophyceae
- Euglena
- Trachelomonas

Pyrrhophyceae
- Peridinium

Rhodophyceae
- Audouinella
- Chantransia - stage

Bacillariophyceae
- Achnanthes
- Cocconeis
- Cyclotella
- Eunotia
- Frustulia
- Gomphonema
- Melosira
- Navicula
- Nitzschia
- Rhopolodia
- Surirella
- Synedra

Cyanophyceae
- Anabaena
- Aphanocapsa
- Lyngbya
- Oscillatoria
- Phormidium
- Rivularia
- Synechocystis

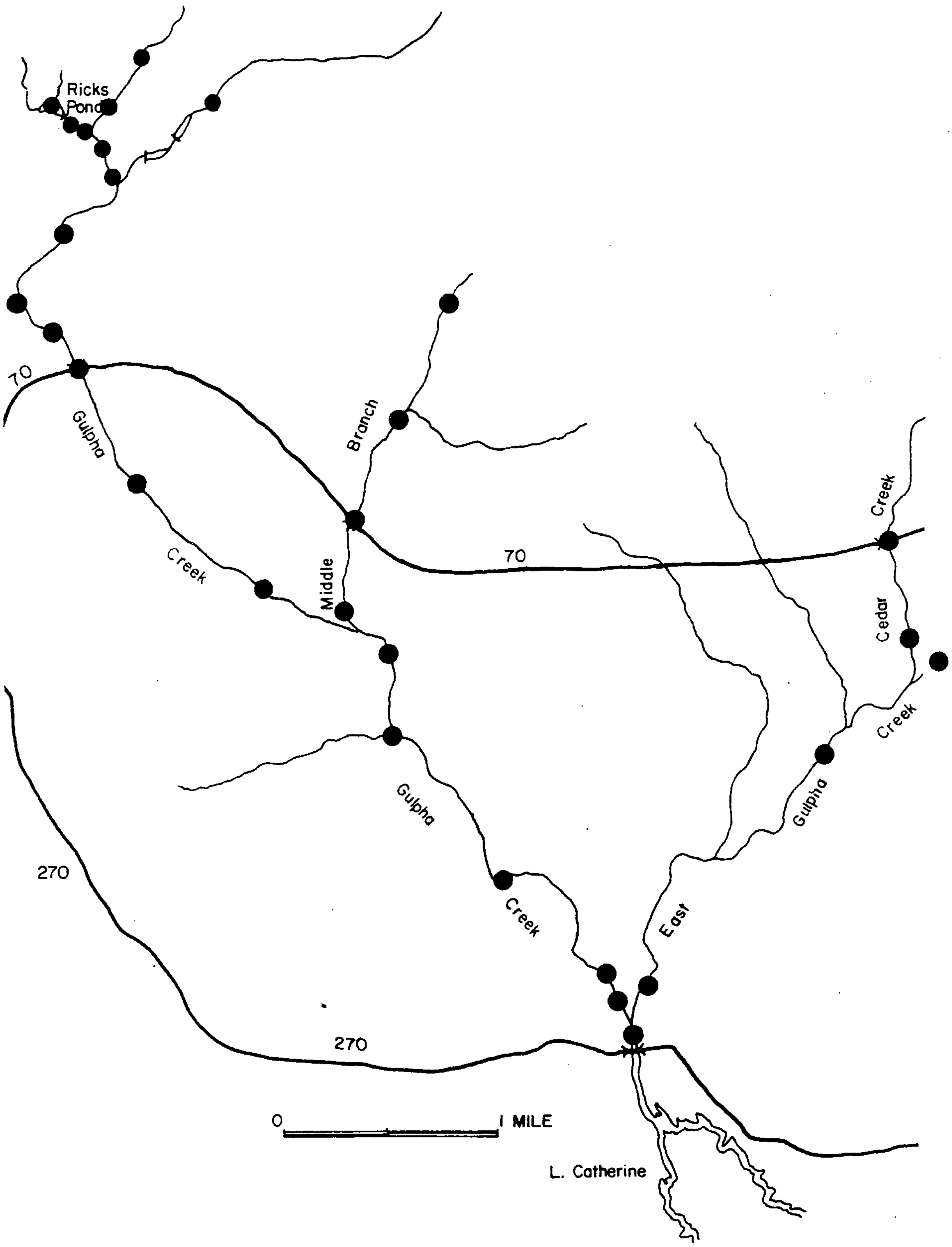
AQUATIC VEGETATION

The higher forms of aquatic vegetation occurring in Ricks Pond and the Gulpha Creek drainage were sampled and identified. The relative abundance and distribution of these rooted, vascular plants were determined by sampling them at each fish collecting site (Figure 7). Seven kinds of higher plants were found in the study area (three species in Ricks Pond, and five species in the Gulpha Creek drainage).

The vegetation in Ricks Pond was confined to within two meters of the bank, and there was no real "vegetation problem" in the pond during the present study. Milfoil (*Myriophyllum* sp.) was the most abundant form and occurred all around the pond margin. The water lily, *Nymphaea*, was the next most common vascular plant in the pond, occurring in four patches (approximately 10-15 m^2) along the north bank. The third form of higher aquatic plant was the cattail, *Typha latifolia*, which occurred in two small patches along the north bank near the foot bridge.

Rooted aquatics were generally sparse along the stream sections investigated. In fact, 13 of the 28 fish sampling sites (46%) had no higher aquatic plants. The most common plant in the creeks was the water willow (*Dianthera*), which was usually found along riffle and pool margins, and in a few cases, extended the width of the stream across shallow, slow riffles. It occurred at 10 (36%) of the sampling sites. The only other widespread aquatic plant in the Gulpha Creek drainage was the milfoil (*Myriophyllum*), which occurred throughout the main Gulpha Creek and in Middle Branch, but was much more abundant in the upper half of the drainage. It was found at eight (29%) localities. Water cress (*Nasturtium*

Figure 7 - Map of the study area showing the fish sampling sites.



officinale) was found in sparse patches in a headwater tributary of Gulpha Creek in DeSoto Park, and at one locality in the upper part of Middle Branch. It occurred in its typical habitat of cool, clear springs. The horsetail (*Equisetum*) was found only in DeSoto Park near the water cress patches. The fifth species of higher aquatic plant found in the Gulpha Creek drainage was the river weed, *Podostemum ceratophyllum*. Small patches of this species were found at one locality in East Gulpha Creek. It occurred in a riffle area, where it was attached to rocks.

ZOOPLANKTON

METHODS

Zooplankton samples were taken from established collecting stations (Figures 5 and 6) within the Ricks Pond drainage system on 10-11 July 1978. Pond samples (Stations 1-5) were obtained by taking vertical tows, bottom to surface, using a 12 cm aperture Wisconsin plankton net equipped with no. 20 mesh. Stream samples were collected by straining 100 l of water through the Wisconsin net. All samples were concentrated to 100 ml and preserved in 3% formalin. A second series of samples was taken from Ricks Pond on 3 August 1978.

In the laboratory, two 1 ml subsamples were taken from each sample and counted directly in a Sedgewick-Rafter counting cell at a magnification of 125x. When *Chaoborus* sp. occurred, all specimens in the entire sample were counted.

RESULTS

The zooplankton data are presented in Tables 13-19. Raw counts were converted to organisms per liter (o/l) in Tables 13 and 14, and to relative density values (Tables 15 and 16), the latter being expressed as percentages of total organisms for each station. Tables 17 and 18 show the data for the August 3 Ricks Pond samples.

A taxonomic outline of all zooplankton organisms recorded from the Ricks Pond drainage system is given in Table 19. This list may not be complete since it was compiled only from the subsamples enumerated; i.e., a qualitative analysis of each entire sample could not be conducted within the allowable time frame.

As an additional note, the virtual absence of zooplankton from Gulpha Creek and East Gulpha Creek is not surprising. Lotic

Table 13 Zooplankton enumeration analysis, Ricks Pond, 11 July 1978. Data are expressed as organisms per liter (o/l).

	Stations 1	2	3	4	5
Rotatoria					
Anuraeopsis sp.		7.35		11.52	1.58
Asplanchna sp.	7.36	14.70			3.16
Collotheca sp.	73.60	46.55	37.92	44.16	112.18
Conochiloides sp.			3.16		3.16
Conochilus sp.	11.04	22.05	3.16	3.84	15.80
Euchlanis sp.		7.35	3.16	5.76	6.32
Kellicottia sp.				7.68	4.74
Keratella sp.	88.72	46.55	66.36	53.76	18.96
Monostyla sp.					1.58
Philodina sp.			3.16		
Platyias sp.	3.68		3.16		
Polyarthra sp.		12.25	3.16	1.92	18.96
Ptygura sp.				1.92	4.74
Synchaeta sp.			3.16	1.92	1.58
Trichocerca spp.		9.80	6.32	3.84	
Unident. bdelloid	3.68				
Total Rotatoria	187.68	166.60	132.72	136.32	192.76
Cladocera					
Bosmina sp.	18.40	4.90	6.32	1.92	
Ceriodaphnia spp.	3.68	9.80	3.16	40.32	
Diaphanosoma sp.	3.68	2.45	6.32		
Total Cladocera	25.76	17.15	15.80	42.24	
Copepoda					
nauplius	154.56	100.45	50.56	51.84	20.54
copepodid			3.16	3.84	1.58
Cyclopoida	3.68			7.68	1.58
Calanoida	7.36	7.35			
Total Copepoda	165.60	107.80	53.72	63.36	23.70
Chaoborus sp.					1.26
Total Organisms	379.04	291.55	202.24	241.92	217.72

Table 14 Zooplankton enumeration analysis, Gulpha Creek (Stations 6-12) and East Gulpha Creek (Stations 13-15), 10 July 1978. Data are expressed as organisms per liter (o/l).

	Stations 6	7	8	9	10	11	12	13	14	15
Rotatoria										
Anuraeopsis sp.										
Asplanchna sp.	0.50									
Collotheca sp.										
Conochiloides sp.										
Conochilus sp.										
Euchlanis sp.										
Kellicottia sp.										
Keratella sp.	1.50							0.50		
Monostyla sp.							0.50	0.50	0.50	
Philodina sp.	0.50									
Platyias sp.										
Polyarthra sp.										
Ptygura sp.										
Synchaeta sp.										
Trichocerca spp.										
Unident. bdelloid										
Total Rotatoria	2.50						0.50	1.00	0.50	
Cladocera										
Bosmina sp.										
Ceridophnia spp.										
Diaphanosoma sp.										
Total Cladocera										
Copepoda										
nauplius	1.00				0.50					
copepodid										
Cyclopoida										
Calanoida										
Total Copepoda	1.00				0.50					
Chaoborus sp.										
Total Organisms	3.50				0.50		0.50	1.00	0.50	

Table 15 - Zooplankton relative densities (%), Ricks Pond, 11 July 1978. Data are expressed as percentages of total organisms for each station.

	STATIONS				
	1	2	3	4	5
Rotatoria					
Anuraeopsis sp.		2.52		4.76	2.18
Asplanchna sp.	1.94	5.04			1.45
Collotheca sp.	19.42	15.97	18.75	18.25	51.52
Conochiloides sp.			1.56		1.45
Conochilus sp.	2.91	7.56	1.56	1.59	7.26
Euchlanis sp.		2.52	1.56	2.38	2.90
Kellicottia sp.				3.17	
Keratella sp.	23.30	15.97	32.81	22.22	8.71
Monostyla sp.					0.73
Philodina sp.			1.56		
Platyias sp.	0.97		1.56		
Polyarthra sp.		4.20	1.56	0.79	8.71
Ptygura sp.				0.79	2.18
Synchaeta sp.			1.56	0.79	0.73
Trichocerca spp.		3.36	3.13	1.59	
Unident. bdelloid	0.97				
Total Rotatoria	49.51	57.14	65.61	56.33	87.82
Cladocera					
Bosmina sp.	4.85	1.68	3.13	0.79	
Ceriodaphnia spp.	0.97	3.36	1.56	16.91	
Diaphanosoma sp.	0.97	0.84	3.13		
Total Cladocera	6.79	5.88	7.82	17.70	
Copepoda					
nauplius	40.78	34.45	25.00	21.43	9.43
copepodid			1.56	1.59	0.73
Cyclopoida	0.97			3.17	0.73
Calanoida	1.94	2.52			
Total Copepoda	43.69	36.97	26.56	26.19	10.89
Chaoborus sp.					0.58

Table 16 Zooplankton relative densities (%), Gulpha Creek (Stations 6-12) and East Gulpha Creek (Stations 13-15), 10 July 1978. Data are expressed as percentages of total organisms for each station.

	Stations 6	7	8	9	10	11	12	13	14	15
Rotatoria										
Anuraeopsis sp.										
Asplanchna sp.	14.29									
Collotheca sp.										
Conochiloides sp.										
Conochilus sp.										
Euchlanis sp.										
Kellicottia sp.										
Keratella sp.	42.86							50.00		
Monostyla sp.							100.00	50.00	100.00	
Philodina sp.	14.29									
Platyias sp.										
Polyarthra sp.										
Ptygura sp.										
Synchaeta sp.										
Trichocerca spp.										
Unident. bdelloid										
Total Rotatoria	71.44						100.00	100.00	100.00	
Cladocera										
Bosmina sp.										
Ceriodaphnia spp.										
Diaphanosoma sp.										
Total Cladocera										
Copepoda										
nauplius	28.57				100.00					
copepodid										
Cyclopoida										
Calanoida										
Total Copepoda	28.57				100.00					
Chaoborus sp.										

Table 17 Zooplankton enumeration analysis, Ricks Pond, 3 August 1978. Data are expressed as organisms per liter (o/l).

	Stations 1	2	3	4	5
Rotatoria					
Anuraeopsis sp.		2.45	6.32	65.28	156.42
Asplanchna sp.	14.72	19.60	31.60	9.60	
Collotheca sp.	33.12	7.35	3.16	7.68	3.16
Conochiloides sp			3.16		
Conochilus sp.	375.36	56.35	34.76	23.04	
Euchlanis sp.	3.68				
Kellicottia sp.	11.04	22.05	6.32	15.36	52.14
Keratella sp.	559.36	144.55	154.84	72.96	53.72
Monostyla sp.					
Philodina sp.					
Platyias sp.					
Polyarthra sp.		2.45		1.92	1.58
Ptygura sp.					
Synchaeta sp.					
Trichocerca spp.	14.72			3.48	9.48
Unident. bdelloid					
Total Rotatoria	1,012.00	254.80	240.16	199.68	276.50
Cladocera					
Bosmina sp.	58.88		3.16		1.58
Ceriodaphnia spp.					
Diaphanosoma sp.					
Total Cladocera	58.88		3.16		1.58
Copepoda					
nauplius	44.16	24.50	25.28	26.88	25.28
copepodid	3.68	17.15		5.76	6.32
Cyclopoida		19.60		3.84	1.58
Calanoida		7.35		1.92	
Total Copepoda	47.84	68.60	25.28	38.40	33.18
Chaoborus sp.		0.20	0.06	0.27	2.24
Total Organisms	1,118.72	323.60	268.66	238.35	313.50

Table 18 Zooplankton relative densities (%), Ricks Pond, 3 August 1978. Data are expressed as percentages of total organisms for each station.

	Stations 1	2	3	4	5
Rotatoria					
Anuraeopsis sp.		0.76	2.35	27.39	49.89
Asplanchna sp.	1.32	6.06	11.76	4.03	
Collotheca sp.	2.96	2.27	1.18	3.22	1.00
Conochiloides sp.			1.18		
Conochilus sp.	33.55	17.41	12.94	9.67	
Euchlanis sp.	0.33				
Kellicottia sp.	0.99	6.81	2.35	6.44	16.63
Keratella sp.	50.00	44.67	57.63	30.61	17.14
Monostyla sp.					
Philodina sp.					
Platyias sp.					
Polyarthra sp.		0.76		0.81	0.50
Ptygura sp.					
Synchaeta sp.					
Trichocerca spp.	1.32			1.61	3.02
Unident. bdelloid					
Total Rotatoria	90.47	78.74	89.39	83.78	88.18
Cladocera					
Bosmina sp.	5.26				0.50
Ceriodaphnia spp.					
Diaphanosoma sp.					
Total Cladocera	5.26				0.50
Copepoda					
nauplius	3.95	7.57	9.41	11.28	8.06
copepodid	0.33	5.30		2.42	2.02
Cyclopoida		6.06		1.61	0.50
Calanoida		2.27		0.81	
Total Copepoda	4.28	21.20	9.41	16.12	10.58
Chaoborus sp.		0.06	0.02	0.11	0.71

Table 19 Taxonomic outline of the zooplankton organisms identified from the Ricks Pond Drainage System.

Phylum Rotatoria
- Class Bdelloidea
  - Family Philodinidae
    - *Philodina* sp.
  - Unidentified bdelloid
- Class Monogononta
  - Order Ploima
    - Family Brachionidae
      - *Anuraeopsis* sp.
      - *Euchlanis* sp.
      - *Kellicottia bostoniensis*
      - *Keratella cochlearis*
      - *Platyias patulus*
    - Family Lecanidae
      - *Monostyla* sp.
    - Family Trichocercidae
      - *Trichocerca capucina*
      - *T. similis*
    - Family Asplanchnidae
      - *Asplanchna priodonta*
    - Family Synchaetidae
      - *Synchaeta* sp.
  - Order Flosculariaceae
    - Family Flosculariidae
      - *Ptygura* sp.
    - Family Conochilidae
      - *Conochiloides* sp.
      - *Conochilus* sp.
  - Order Collothecaceae
    - Family Collothecidae
      - *Collotheca* sp.

Phylum Arthropoda
- Class Crustacea
  - Subclass Branchiopoda
    - Order Cladocera
      - Family Sididae
        - *Diaphanosoma leuchtenbergianum*
      - Family Bosminidae
        - *Bosmina longirostris*
      - Family Daphnidae
        - *Ceriodaphnia lacustris*
        - *C. quadrangula*
  - Subclass Copepoda
    - Order Eucopepoda
      - Immature stages
        - nauplius
        - copepodid
      - Mature stages
        - Suborder Cyclopoida
        - Suborder Calanoida
- Class Insecta
  - Order Diptera
    - Family Culicidae
      - *Chaoborus* sp.

systems of this sort would not be expected to support autochthonous zooplankton communities. The very occasional specimens encountered must be considered accidental.

BENTHOS

METHODS

The benthic macroinvertebrates were sampled at the same five stations in Ricks Pond and the same ten stations in Gulpha Creek (Figures 5 and 6) as were the phytoplankton, periphyton, and zooplankton. Five samples were taken from Ricks Pond on 11 July 1978, using an Ekman bottom dredge (stations 1-5). Seven samples were taken from Gulpha Creek (stations 6-12), and three samples were taken from East Gulpha Creek (stations 13-15), using a Surber square-foot sampler on 10 July 1978. Two Surber samples were taken at each stream locality. All samples were preserved in 5% formalin.

Prior to the sampling at the established stations, benthic organisms were preserved at several localities on 23 and 24 June 1978, during a preliminary fish survey of the study area. These benthic forms were captured, along with the fishes, at these sites in 4' x 6' nylon minnow seines of one-eighth inch mesh.

RESULTS

All benthic samples were hand sorted in the laboratory, and all specimens in each sample were identified to at least the generic level where possible and enumerated. The enumeration data are presented in Tables 20-24 for the 15 established sampling stations. Tables 20 and 21 list the number of organisms contained in each sample; Tables 22 and 23 list the percentage of total organisms for each species by station; and Table 24 contains a taxonomic summary of all benthic organisms taken in the fifteen samples from Ricks Pond and Gulpha Creek.

The different kinds of benthic organisms collected in the

Table 20 - Benthos enumeration data, Gulpha Creek, 10 July 1978 (number of organisms in each sample)

	STATIONS									
	6	7	8	9	10	11	12	13	14	15
Tricladida										
Dugesia sp.			2	1		2				
Lumbricidae	3	3			2		1	2	14	7
Glossiphoniidae				3						
Amnicolidae		1	9	148	38	18	2			
Viviparidae				1			7	2		
Planorbidae										
Helisoma sp.				1						
Ancylidae										
Ferrissia sp.				1						
Astacidae										
Orconectes sp.	3				3	1		2	1	2
Corydalidae										
Chauliodes sp.			2							
Heptogeniidae										
Stenonema sp.	1	6	23		29	1	7	17	12	1
Baetidiae										
Heptagenia sp.	1									
Isonychia sp.				7		1		3	9	
Hydropsychidae										
Cheumatopsyche sp.			1	14	67	2		6		2
Helicopsychidae										
Helicopsyche sp.									6	
Philopotamidae										
Chimarra sp.				1		5				
Perlidae										
Neoperla sp.					2				11	2
Tendipendidae										
Pentoneura sp.	12						3			
Tabanidae										
Tabanus sp.									2	
Psephenidae										
Psephenus herricki		2	2				2	3	17	16
Elmidae			2			1			2	
Coenagrionidae				1	1		1			
TOTALS	20	12	41	178	142	31	23	35	74	30

Table 21 - Benthos enumeration data, Ricks Pond, 11 July 1978
(number of organisms in each sample)

	STATIONS				
	1	2	3	4	5
Lumbricidae	25	20	30	7	
Culcidae Chaoborus sp.	1	53	24	76	119
Tipulidae Tipula sp.			4		
Total	26	73	58	83	119

Table 22 - Benthos enumeration data (percent of total organisms in each sample) Gulpha Creek, 10 July 1978.

	STATIONS									
	6	7	8	9	10	11	12	13	14	15
Tricladida										
Dugesia sp.			4.88	0.56		6.45				
Lumbricidae	15.00	25.00			1.41		4.35	5.71	18.92	23.3
Glossiphoniidae				1.69						
Amnicolidae		8.33	21.95	83.15	26.76	58.06	8.70			
Viviparidae				0.56			30.43	5.71		
Planorbidae										
Helisoma sp.				0.56						
Ancylidae										
Ferrissia sp.				0.56						
Astacidae										
Orconectes sp.	15.00				2.11	3.23		5.71	1.35	6.6
Corydalidae										
Chauliodes sp.			4.88							
Heptogeniidae										
Stenonema sp.	5.00	50.00	56.10		20.42	3.23	30.43	48.57	16.22	3.3
Heptagenia sp.	5.00									
Baetidae										
Isonychia sp.				3.93		3.23		8.57	12.16	
Hydropsychidae										
Cheumatopsyche sp.			2.43	7.87	47.18	6.45		17.14		6.67
Helicopsychidae										
Helicopsyche sp.									8.11	
Philopotamidae										
Chimarra sp.				0.56		16.13				
Perlidae										
Neoperla sp.					0.70				14.86	6.67
Tendipendidae										
Pentoneura sp.	60.00						13.04			
Tabanidae										
Tabanus sp.									2.70	
Psephenidae										
Psephenus herricki	16.67	4.88					8.70	8.57	22.97	53.33
Elmidae		4.88				3.23			2.70	
Coenagrionidae				0.56	0.70		4.35			

Table 23 - Benthos enumeration data (percent of total organisms in each sample), Ricks Pond, 11 July 1978

	STATIONS				
	1	2	3	4	5
Lumbricidae	96.15	27.40	51.72	8.43	
Culcidae					
Chaoborus sp.	3.85	72.60	41.38	91.57	100.00
Tipulidae					
Tipula sp.			6.90		

Table 24 - Texonimic summary of benthic organisms identified from Ricks Pond and the Gulpha Creek drainage system at the 15 sampling stations.

Phylum Platyhelminthes
  Class Turbellaria
    Order Seriata
      Sub-order Tricladida
        Dugesia sp.

Phylum Annelida
  Class Oligochaeta
    Order Haplotaxida
      Family Lumbricidae
  Class Hirudinea
    Order Arhynchobdellida
      Family Glossiphoniidae

Phylum Molluska
  Class Gastropoda
    Order Ctenobranchiata
      Family Amnicolidae
      Family Viviparidae
    Order Pulmonata
      Family Planorbidae
        Helisoma sp.
      Family Ancylidae
        Ferrissia sp.

Phylum Arthropoda
  Class Crustacea
    Order Decapoda
      Family Astacidae
        Orconectes sp.
  Class Insecta
    Order Megaloptera
      Family Corydalidae
        Chauliodes sp.
    Order Ephemenoptera
      Family Heptageniidae
        Stenonema sp.
        Heptagenia sp.
      Family Baetidae
        Isonychia sp.
    Order Trichoptera
      Family Hydropsychidae
        Cheumatopsyche sp.
      Family Helicopsychidae
        Helicopsyche sp.
      Family Philopotamidae
        Chimarra sp.
    Order Plecoptera
      Family Perlidae
        Neoperla sp.
    Order Diptera
      Family Tendipendidae
        Pentaneura sp.

Table 24. - (continued)

Family Culicidae
  Chaoborus sp.
Family Tabanidae
  Tabanus sp.
Family Tipulidae
  Tipula sp.
Order Coeloptera
  Family Psephenidae
    Psephenus
  Family Elmidae
Order Odonata
  Family Coenagrionidae

preliminary samples of 23 and 24 June 1978, are listed in Table 25 along with the number of collections in which they appeared. Only the dragonfly larvae, Hagenium brevistylus, and two unidentified species in the families, Aeschnidae and Gomphidae, were found exclusively in these preliminary samples and not in the later samples taken at the 10 stations in Gulpha Creek.

Table 25.- Summary of benthic organisms identified from the preliminary Gulpha Creek survey of 23, 24 June 1978.

Benthic organism	Number of collections appeared in
Lumbricidae	1
Amnicolidae	6
Astacidae	
Orconectes sp.	11
Corydalidae	
Corydalus cornutus	2
Heptogeniidae	
Stenonema sp.	1
Heptagenia sp.	1
Helicopsychidae	
Helicopsyche sp.	1
Hydropsychidae	
Cheumatopsyche sp.	1
Psephenidae	
Psephenus herricki	1
Aeschnidae	
Unidentified sp.	1
Gomphidae	
Hagenius brevistylus	1
Unidentified sp.	1

FISHES

METHODS

A survey of the fishes of Ricks Pond and the Gulpha Creek drainage was conducted from 1 June 1978, through 21 August 1978. Thirty two samples of fishes were collected from 29 localities throughout the study area (Figure 7) to determine the distributional patterns of the fishes present. Thirty of these samples were taken from the Gulpha Creek drainage with 10' x 4' and 20' x 4' nylon seines of 1/8 inch mesh, and a 30' x 4' seine of 1/4 inch mesh. One fish sample was taken from Ricks Pond with five standard 125' x 6' experimental gill nets consisting of panels of ½, 1, 1¼, 1½, and 2 inches bar measure mesh. One small portion of Ricks Pond was sampled chemically with rotenone with the aid of Arkansas Game and Fish Commission biologists.

Most of the fish samples from the collecting sites were preserved in a 10% formalin solution and transported to the laboratory for identification. Some fish collections were identified and enumerated in the field, and the fishes subsequently released alive.

RESULTS AND DISCUSSION

A list of the fishes collected throughout the study area is presented in Table 26. This table also shows the number of collections a species appeared in and the percent of the total collecting sites (out of 29) where each species was represented. The common and scientific names used for species follow Bailey et al. (1970). A separate distribution map is also provided for each fish species (Figures 8-35).

Twenty-seven species and one hybrid between two of those

Table 26.- List of fishes collected from Ricks Pond and the Gulpha Creek drainage. Also given are the number and per cent of the collecting sites at which each species was found.

Fish species (common name)	Number of sampling sites collected	Per cent of total sampling sites
1. Gizzard shad	2	7
2. Grass pickerel	2	7
3. Stoneroller	18	62
4. Carp	1	3
5. Golden shiner	1	3
6. Bigeye shiner	16	55
7. Striped shiner	13	45
8. Redfin shiner	8	28
9. Bluntnose minnow	4	14
10. Creek chub	4	14
11. Northern hog sucker	8	28
12. Golden redhorse	1	3
13. Black bullhead	3	10
14. Yellow bullhead	4	14
15. Channel catfish	1	3
16. Tadpole madtom	2	7
17. Northern studfish	22	76
18. Blackspotted topminnow	13	45
19. Mosquitofish	2	7
20. Brook silverside	3	10
21. Green sunfish	9	31
22. Bluegill	8	28
23. Longear sunfish	19	66
24. Green sunfish X Bluegill hybrid	1	3
25. Spotted bass	2	7
26. Largemouth bass	10	34
27. Creole darter	5	17
28. Orangebelly darter	25	86

Figure 8 - Distribution map for the gizzard shad, Dorosoma cepedianum.

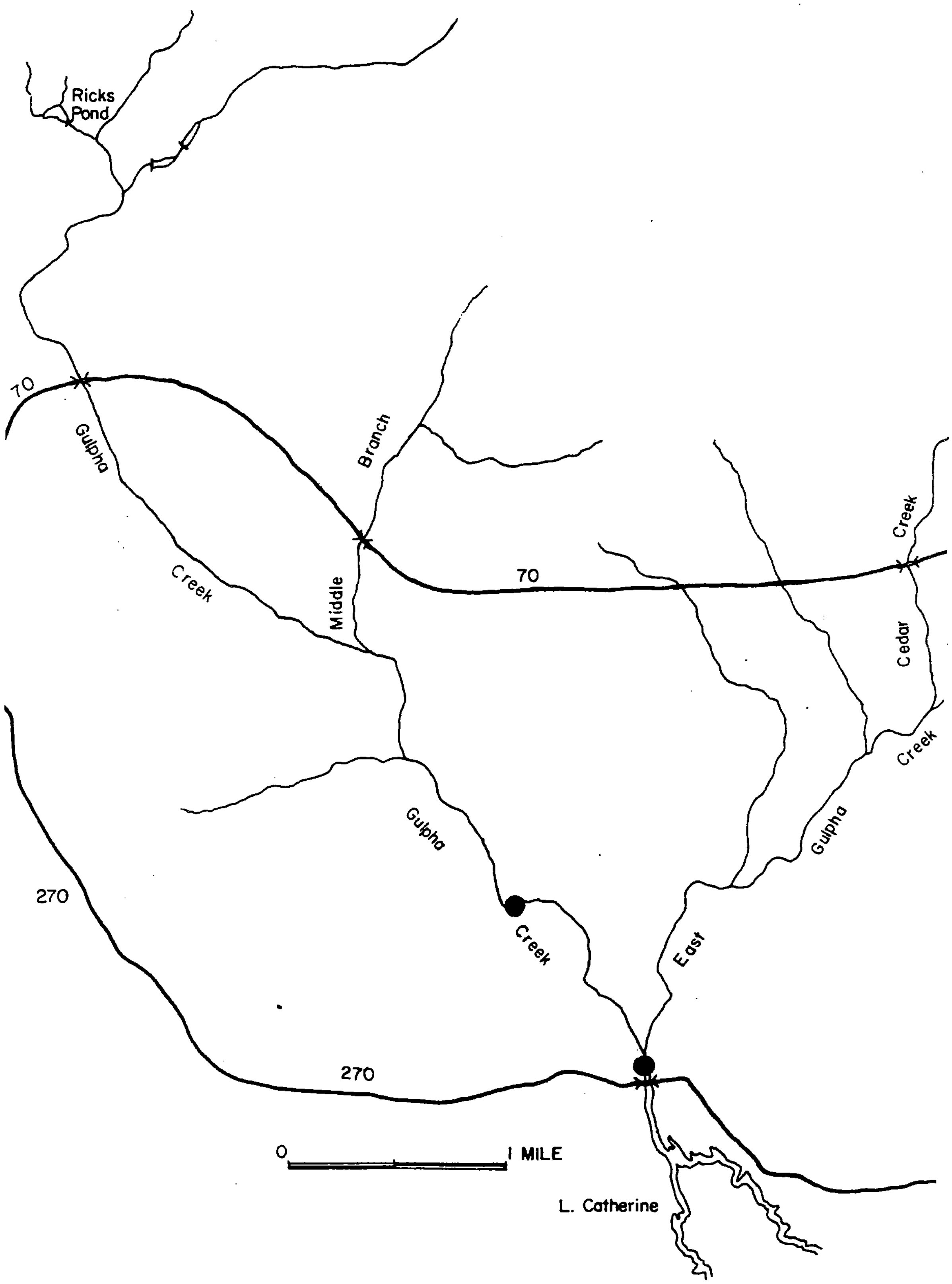


Figure 9 - Distribution map for the grass pickerel, *Esox americanus*.

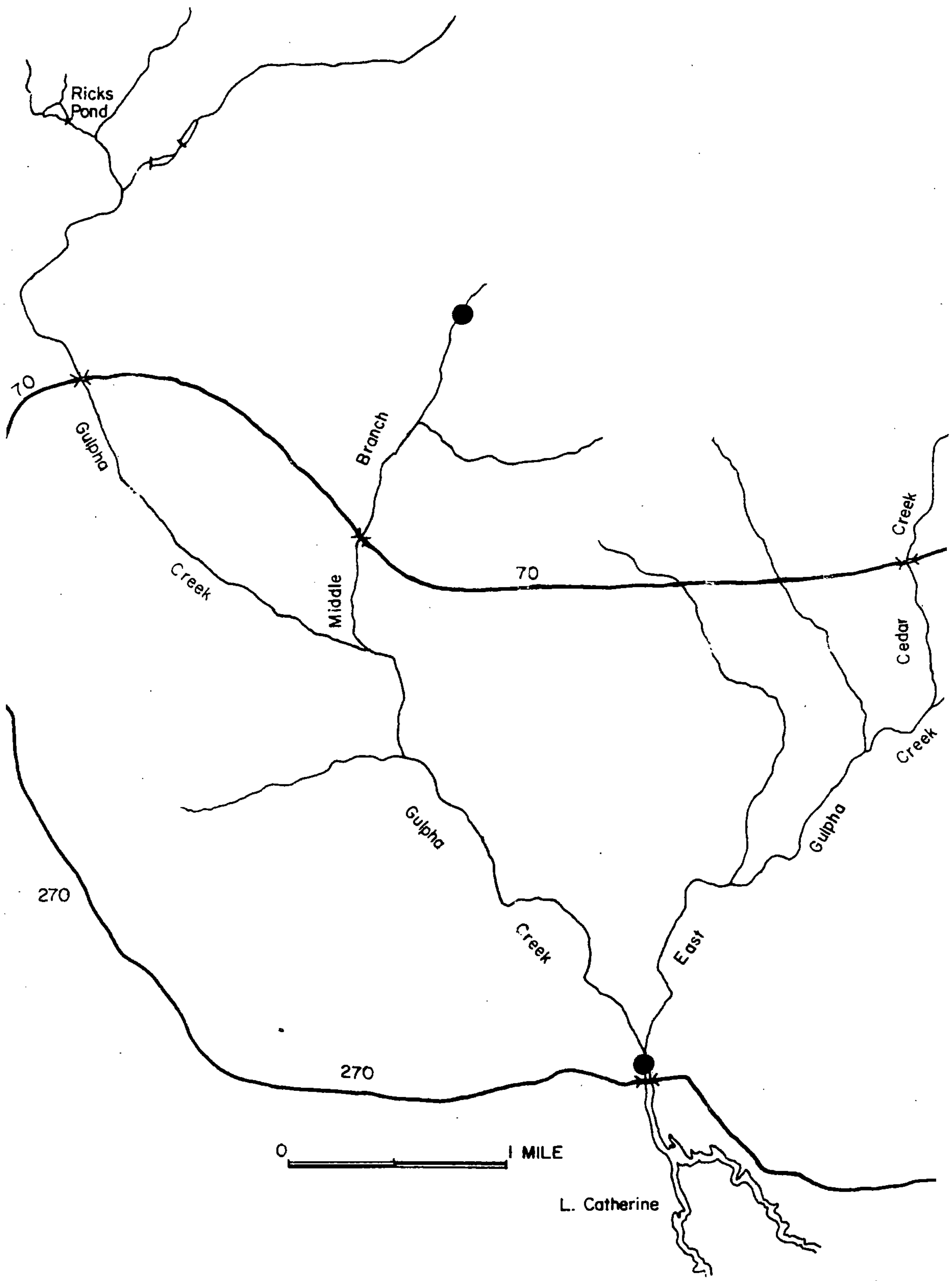


Figure 10 - Distribution map for the stoneroller, Campostoma anomalum.

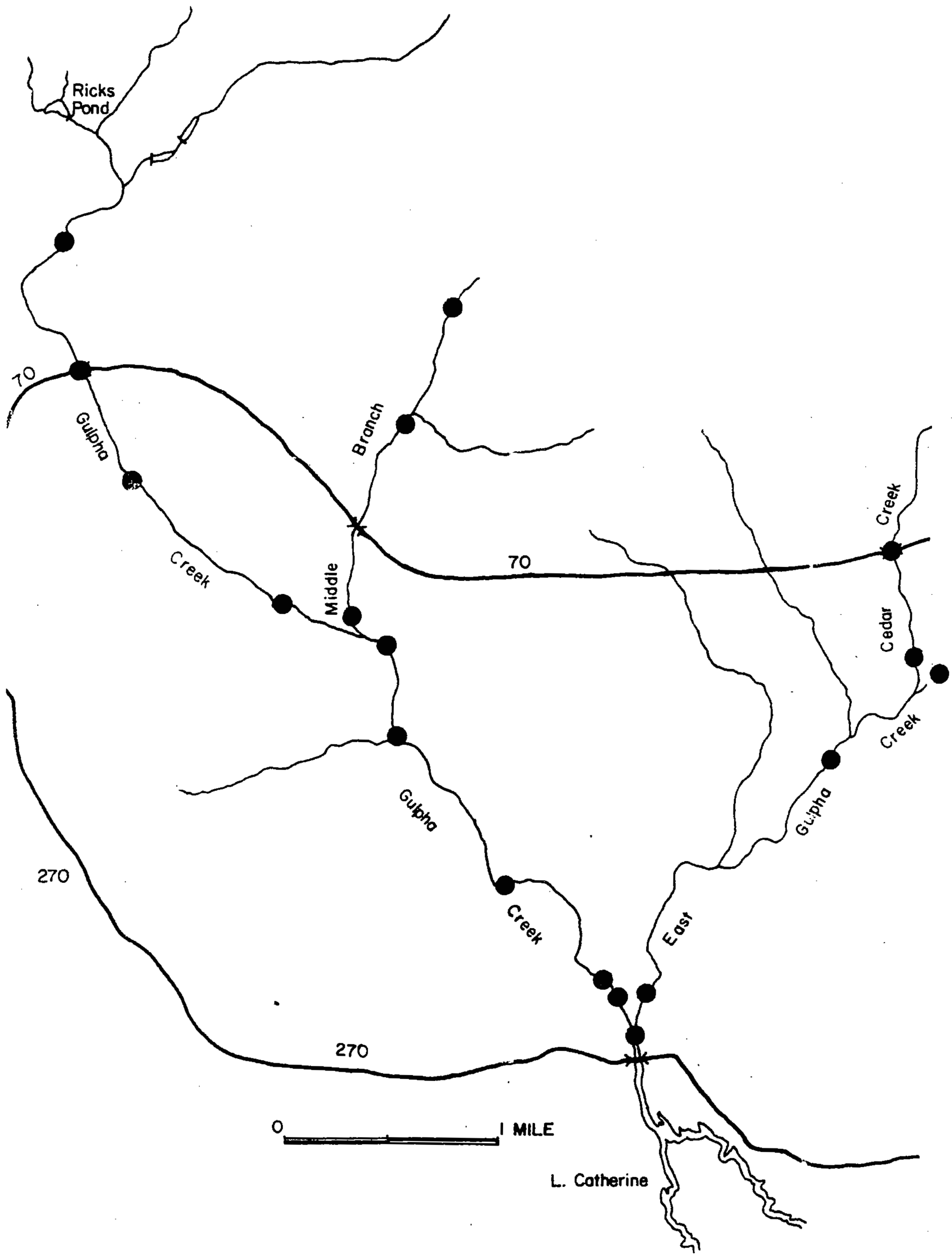


Figure 11 - Distribution map for the carp, <u>Cyprinus carpio</u>.

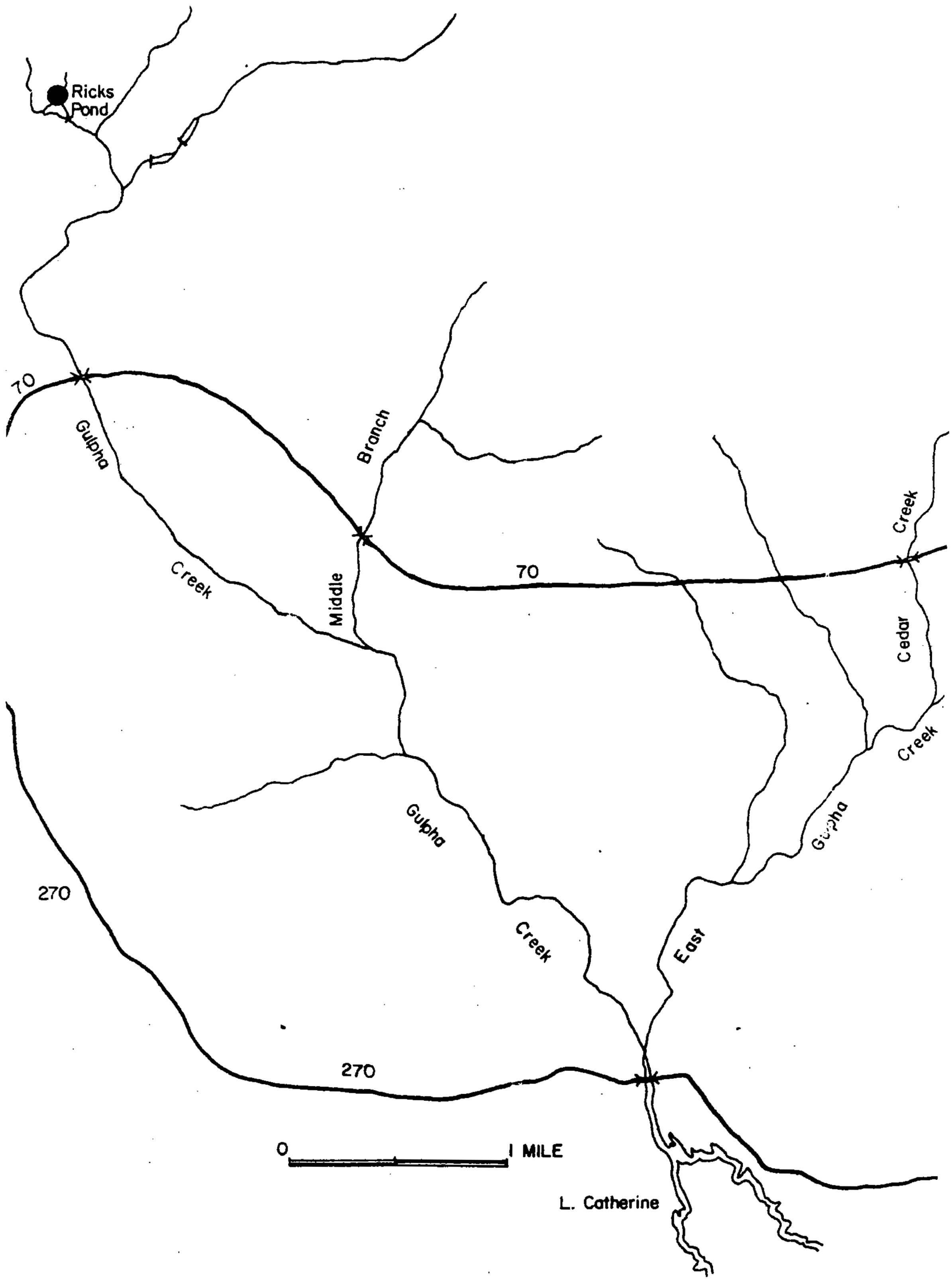


Figure 12 - Distribution map for the golden shiner, Notemigonus crysoleucas.

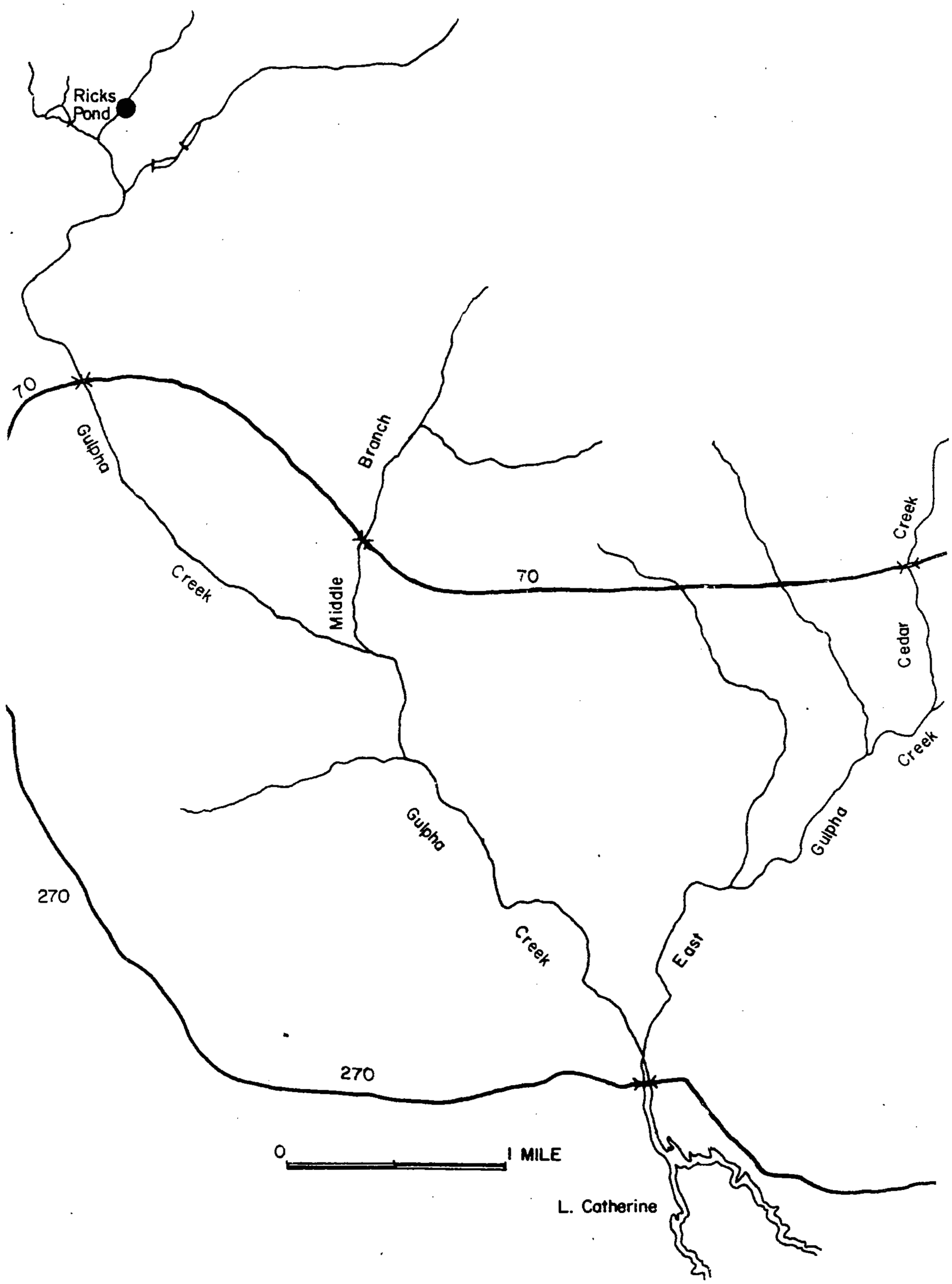


Figure 13 - Distribution map for the bigeye shiner, Notropis boops.

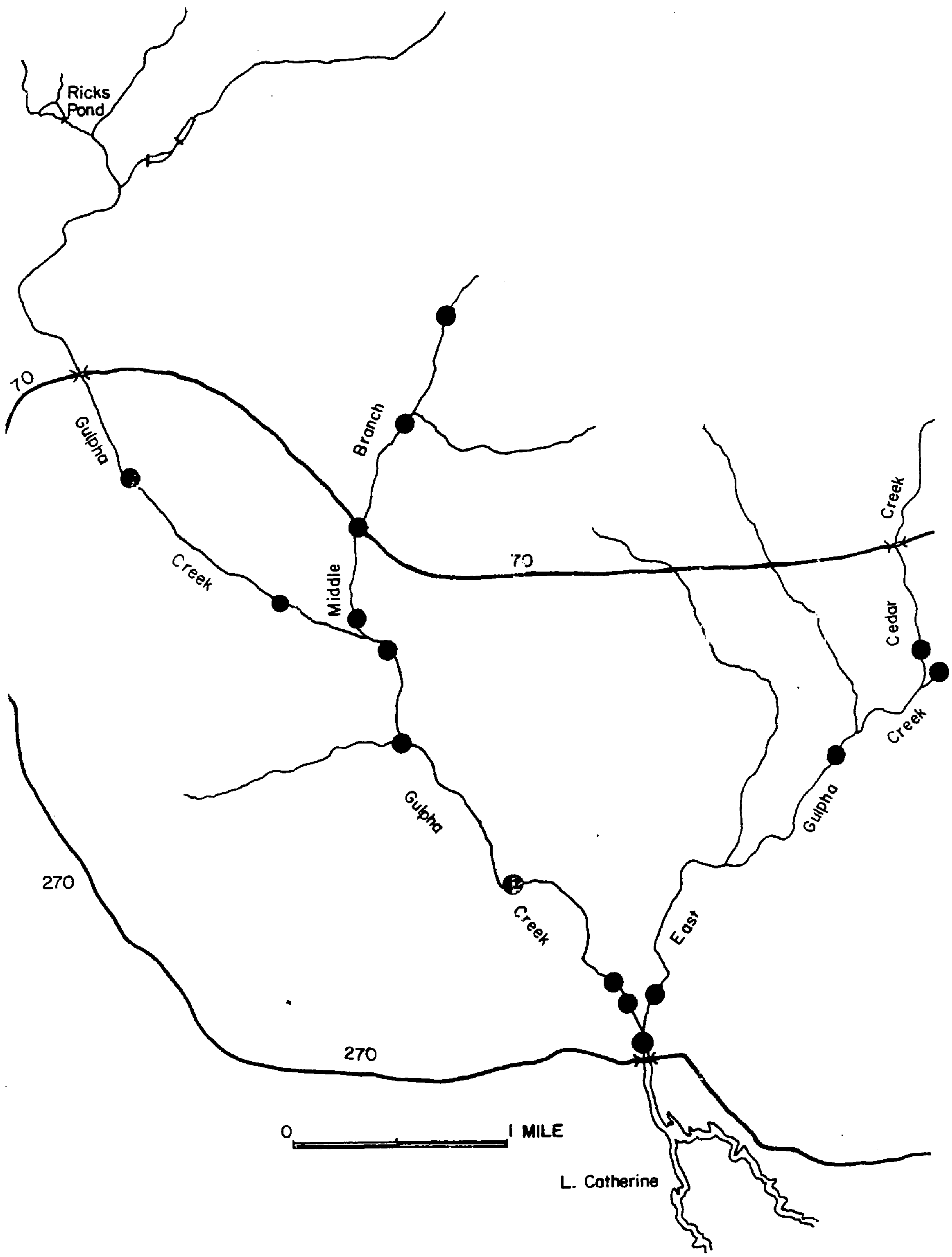


Figure 14 - Distribution map for the striped shiner, Notropis chrysocephalus.

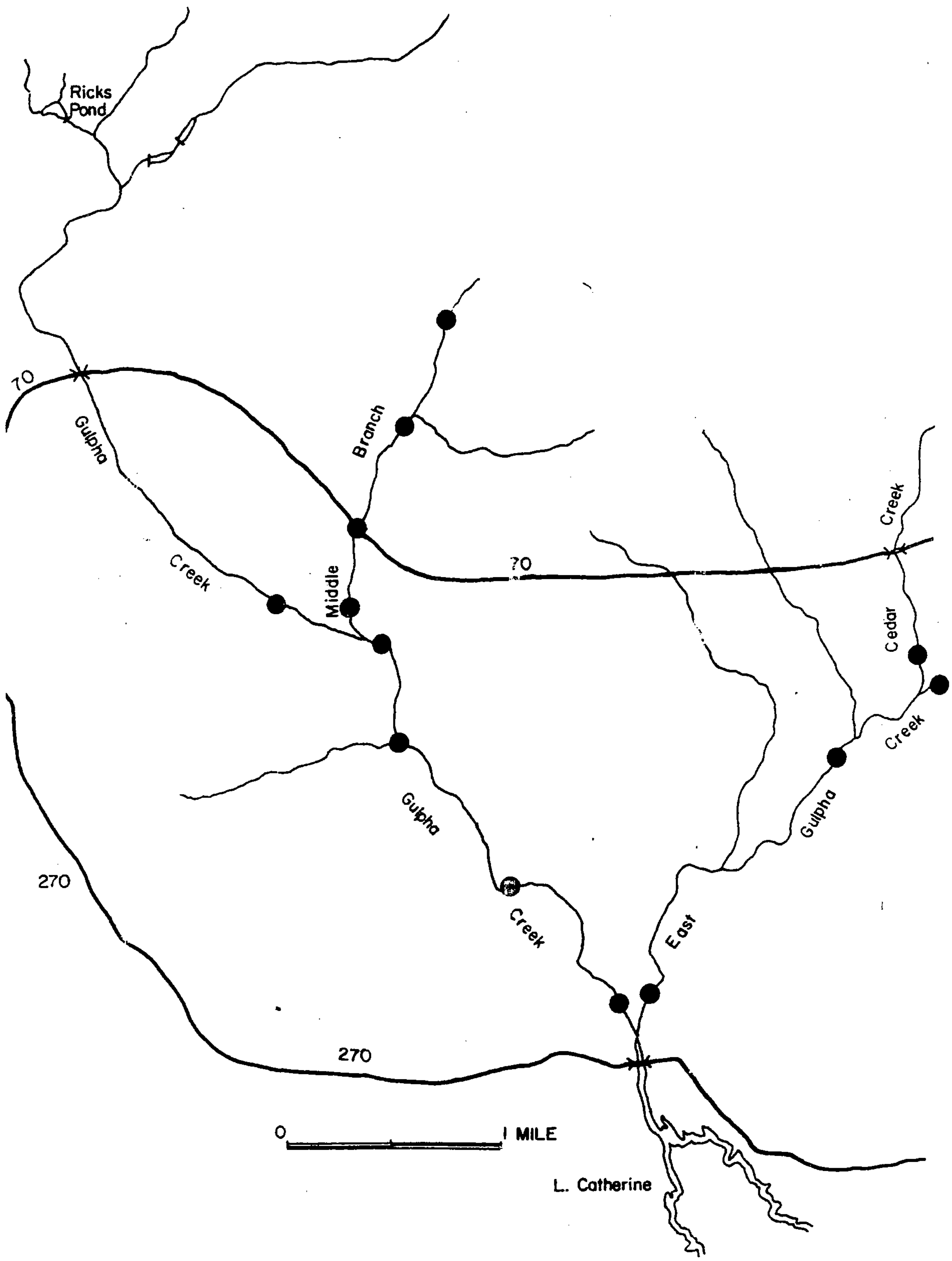


Figure 15 - Distribution map for the redfin shiner, Notropis umbratilis.

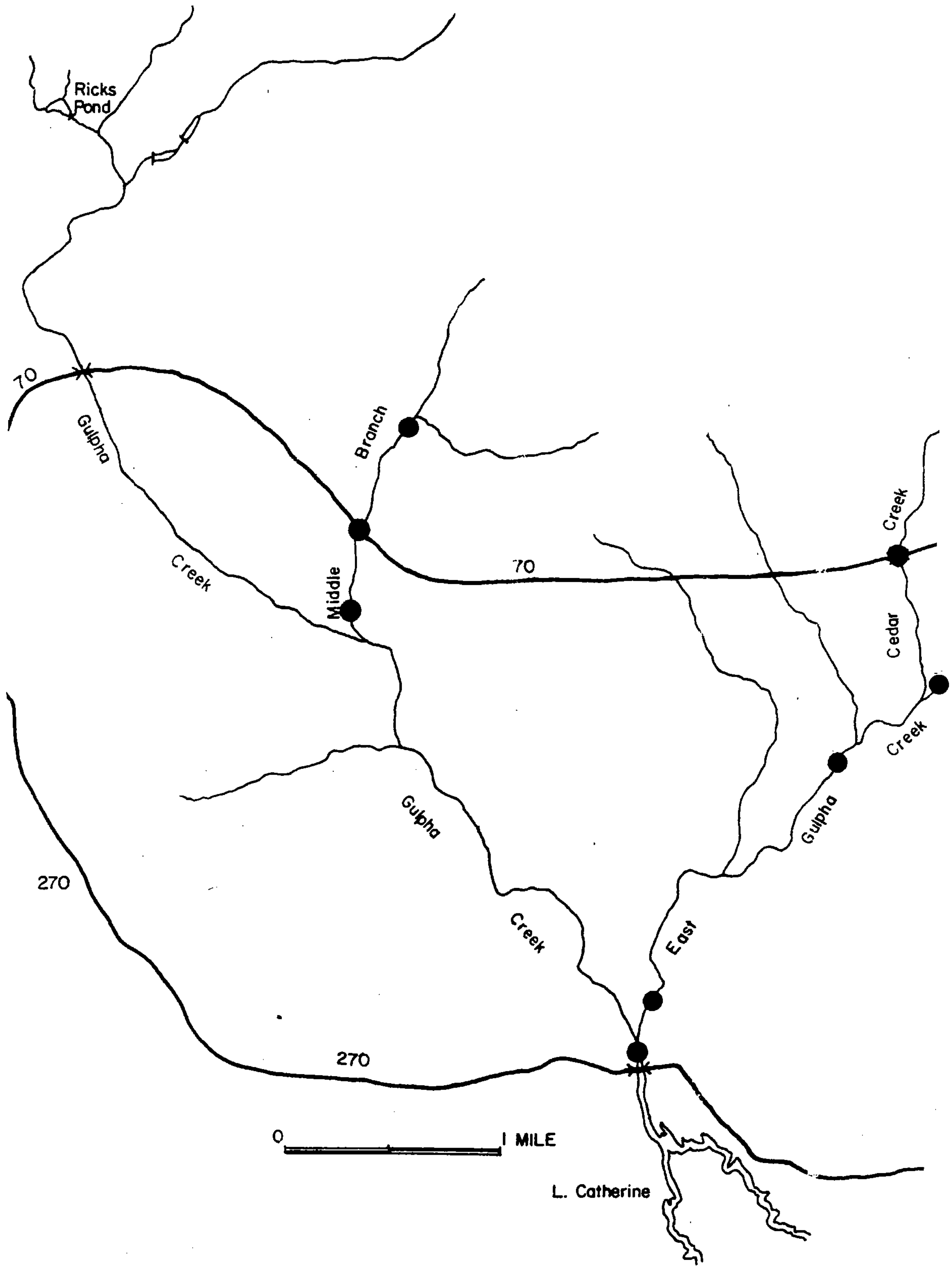


Figure 16 - Distribution map for the bluntnose minnow, <u>Pimephales vigilax</u>.

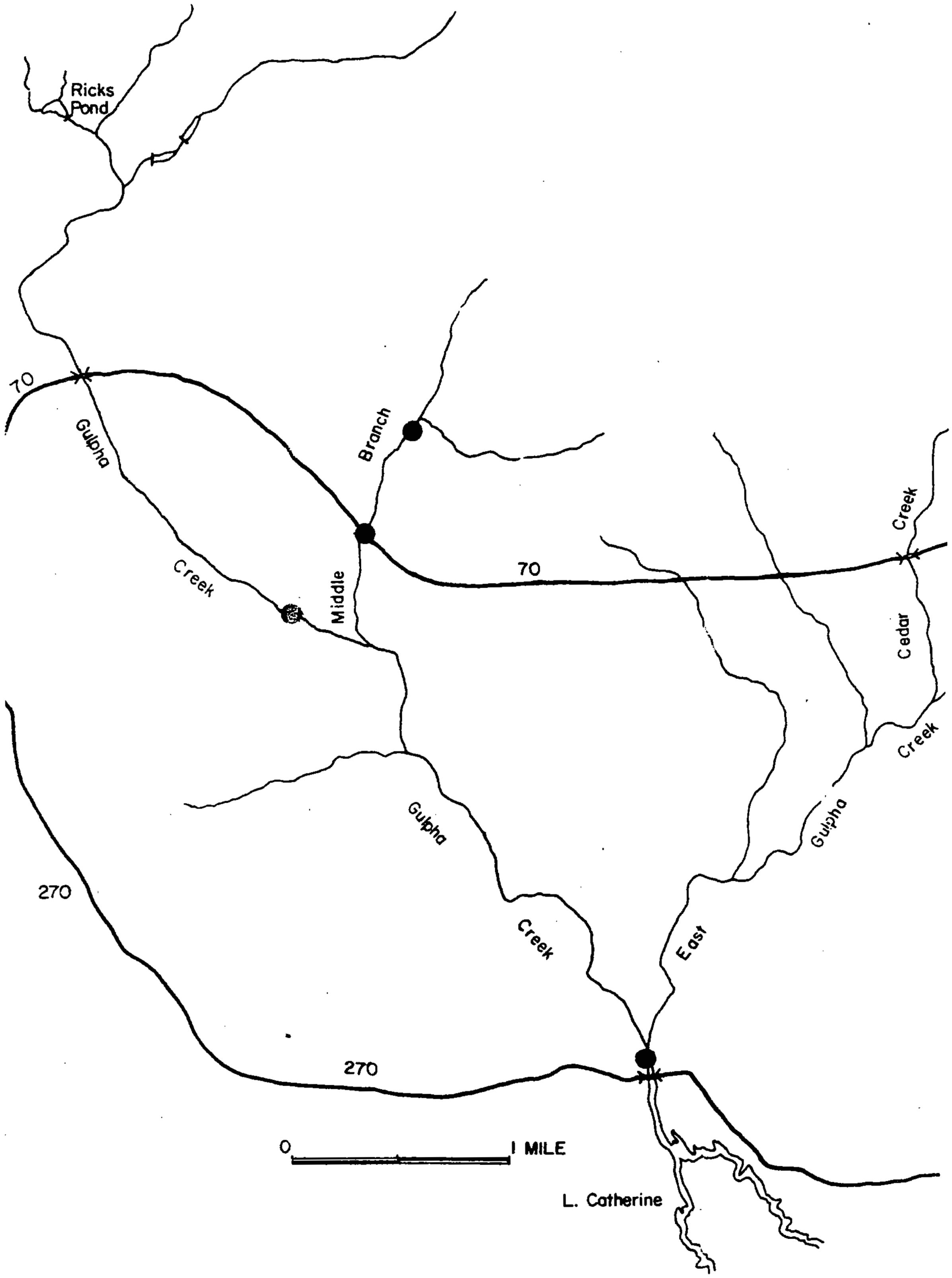


Figure 17 - Distribution map for the creek chub, Semotilus atromaculatus.

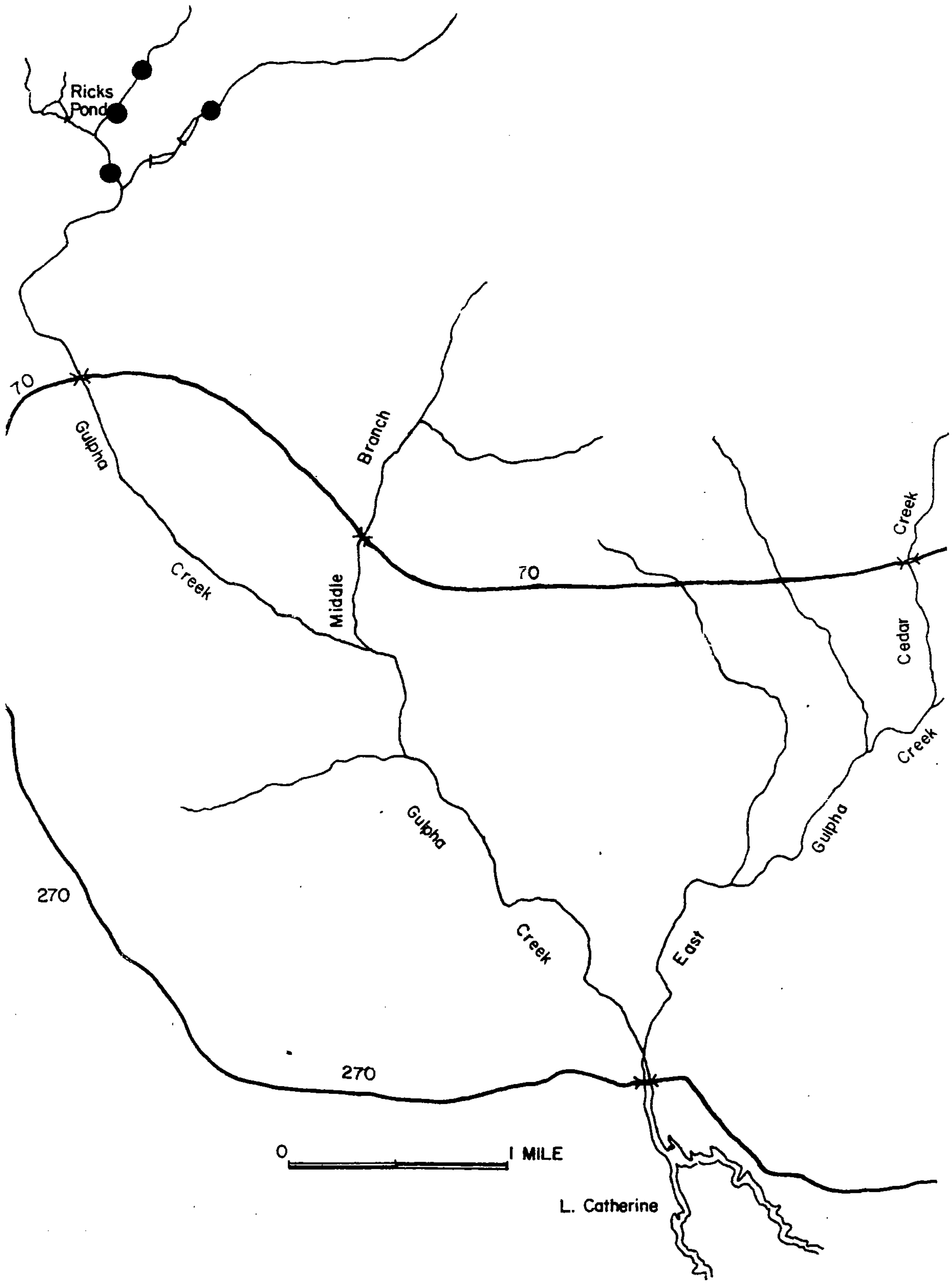


Figure 18 - Distribution map for the northern hog sucker, Hypentelium nigricans.

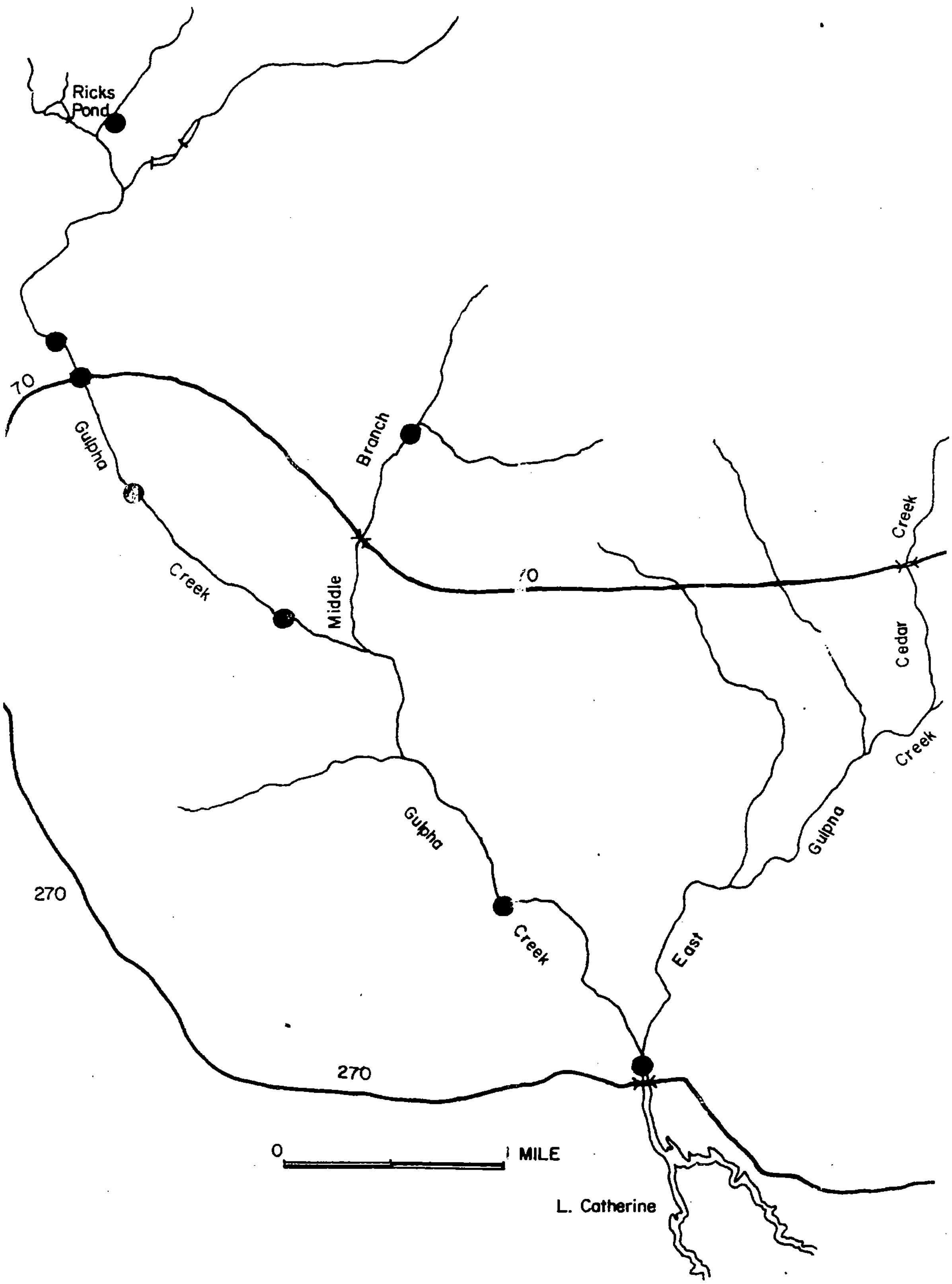


Figure 19 - Distribution map for the golden redhorse, <u>Moxostoma erythrurum</u>.

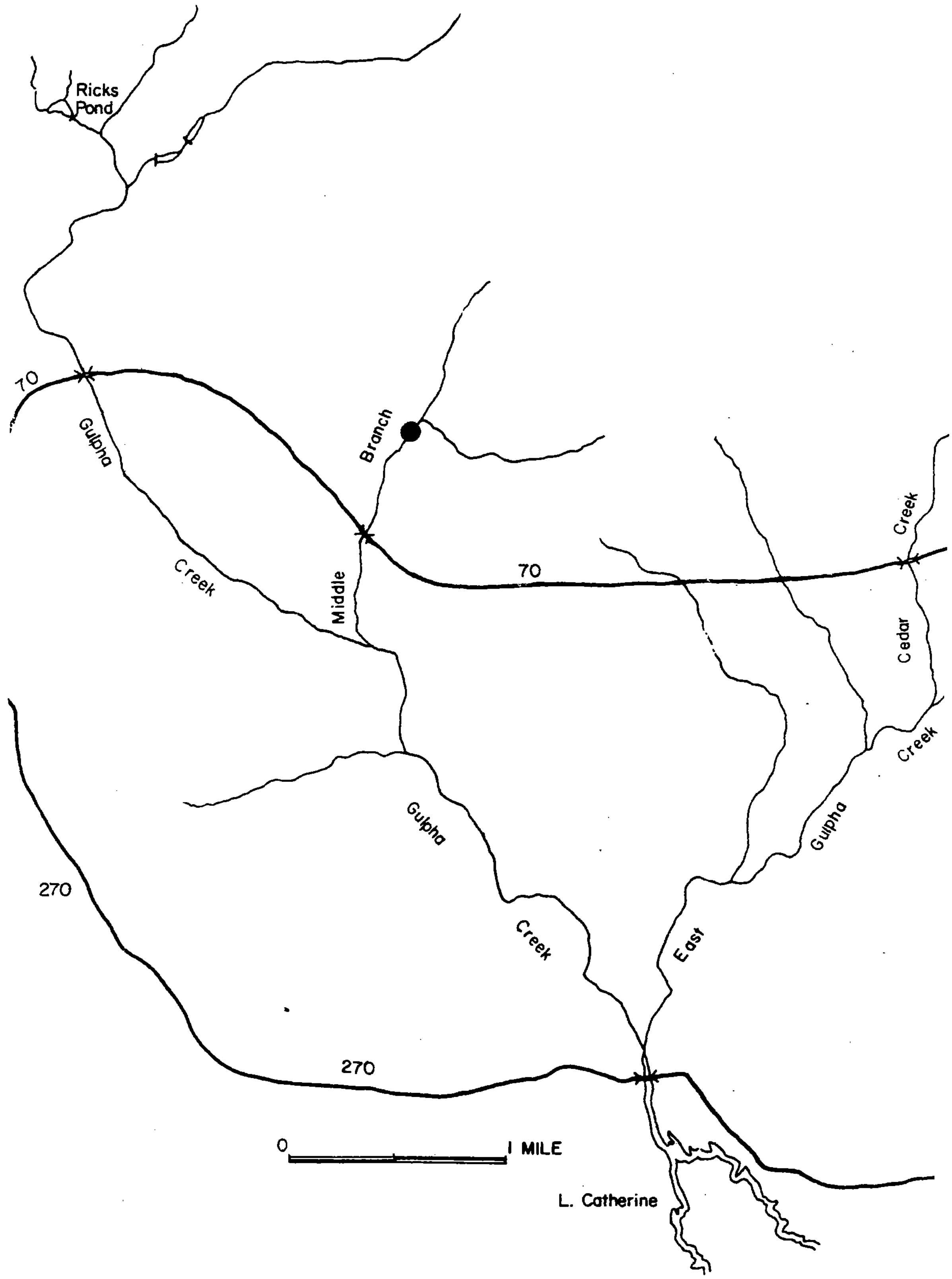


Figure 20 - Distribution map for the black bullhead, *Ictalurus melas*.

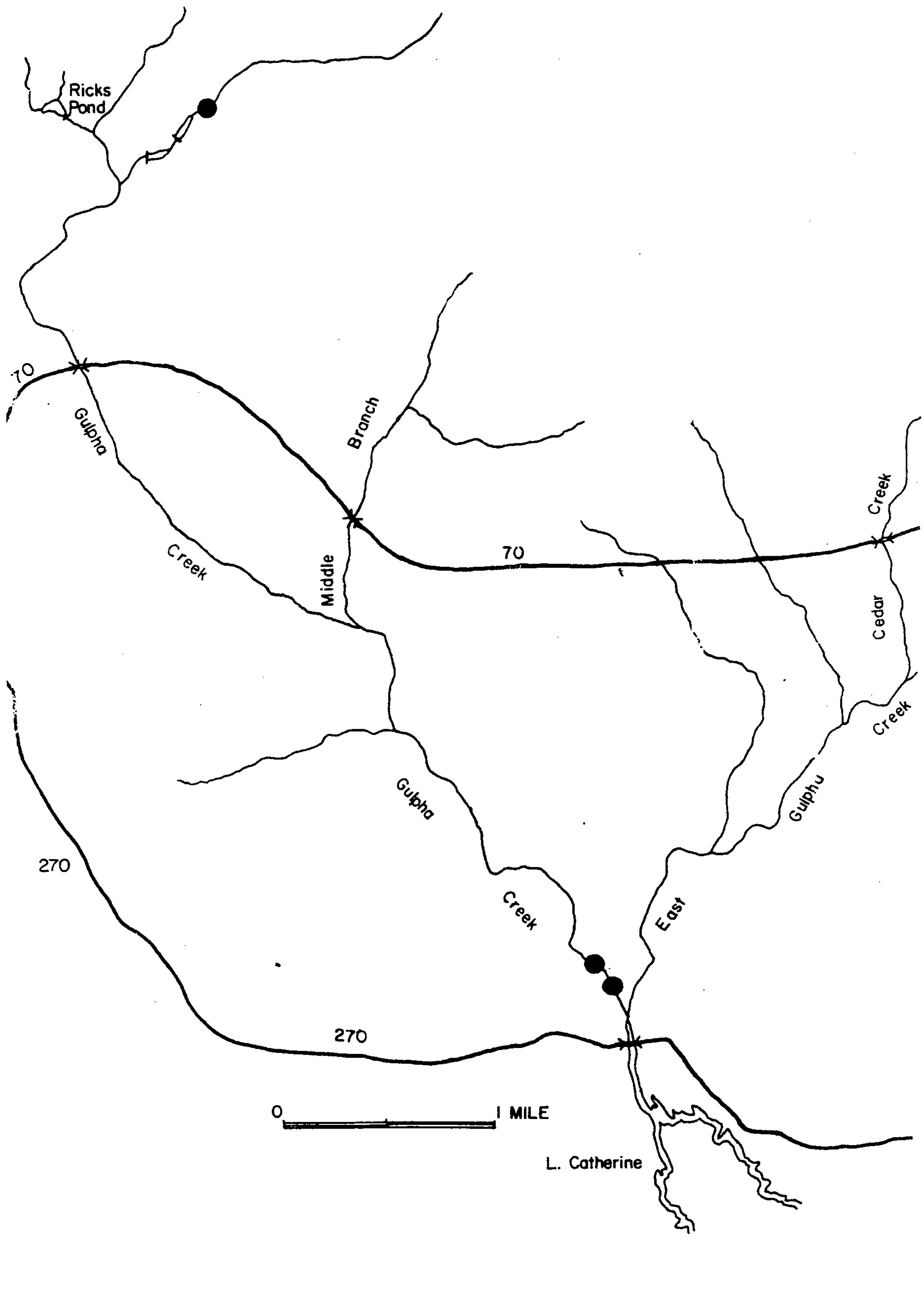


Figure 21 - Distribution map for the yellow bullhead, Ictalurus natalis.

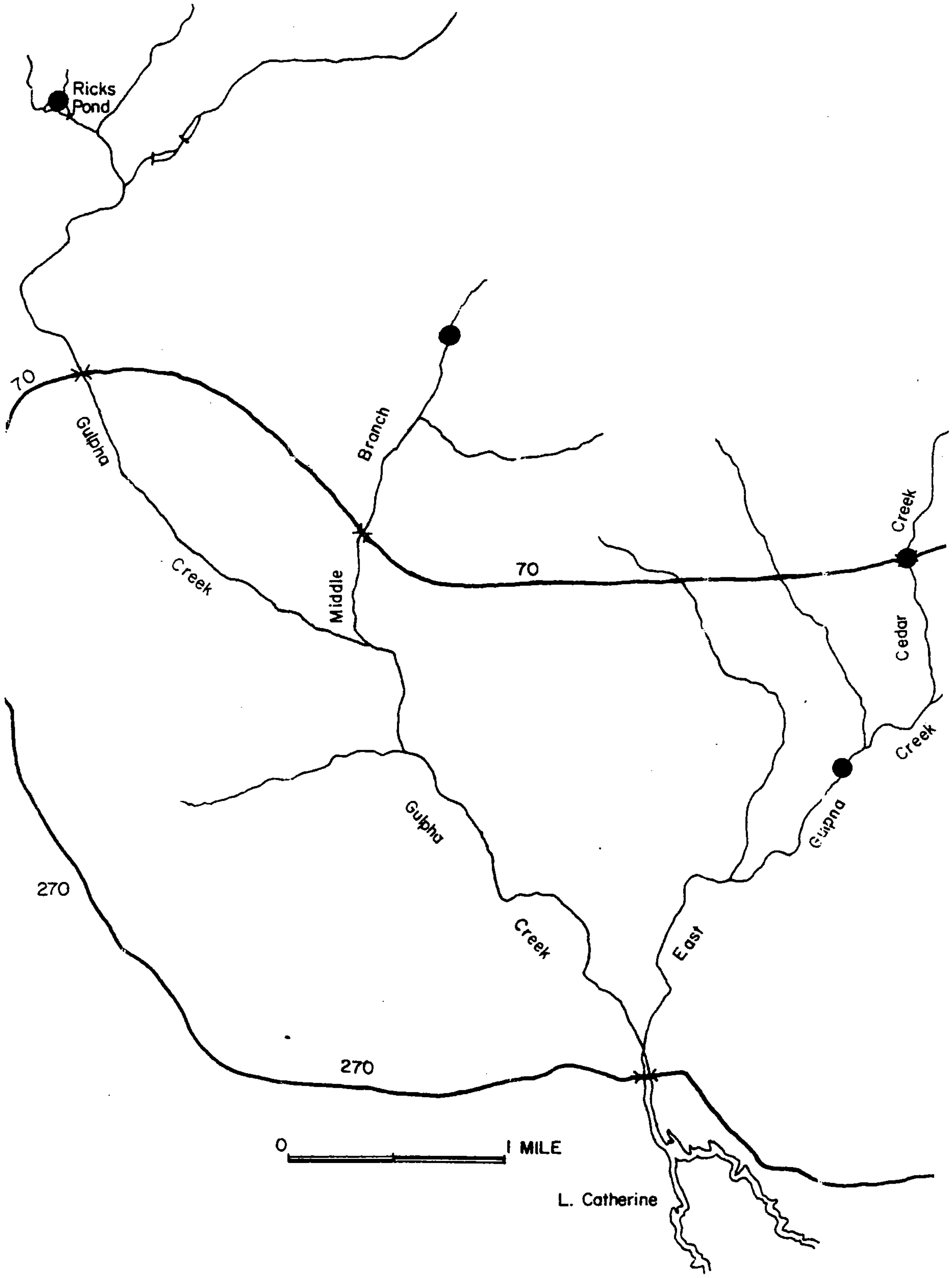


Figure 22 - Distribution map for the channel catfish, Ictalurus punctatus.

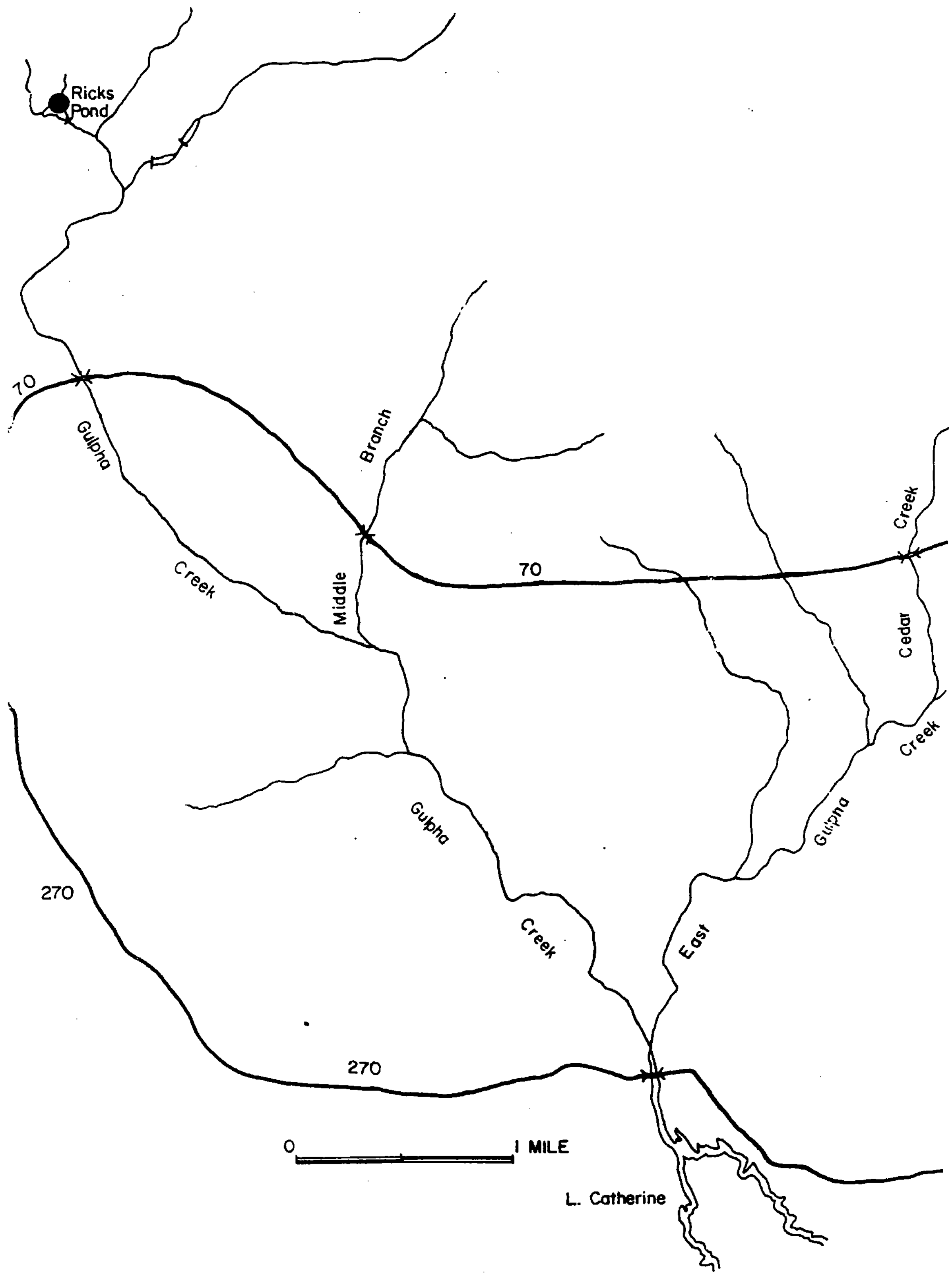


Figure 23 - Distribution map for the tadpole madtom, Noturus gyrinus.

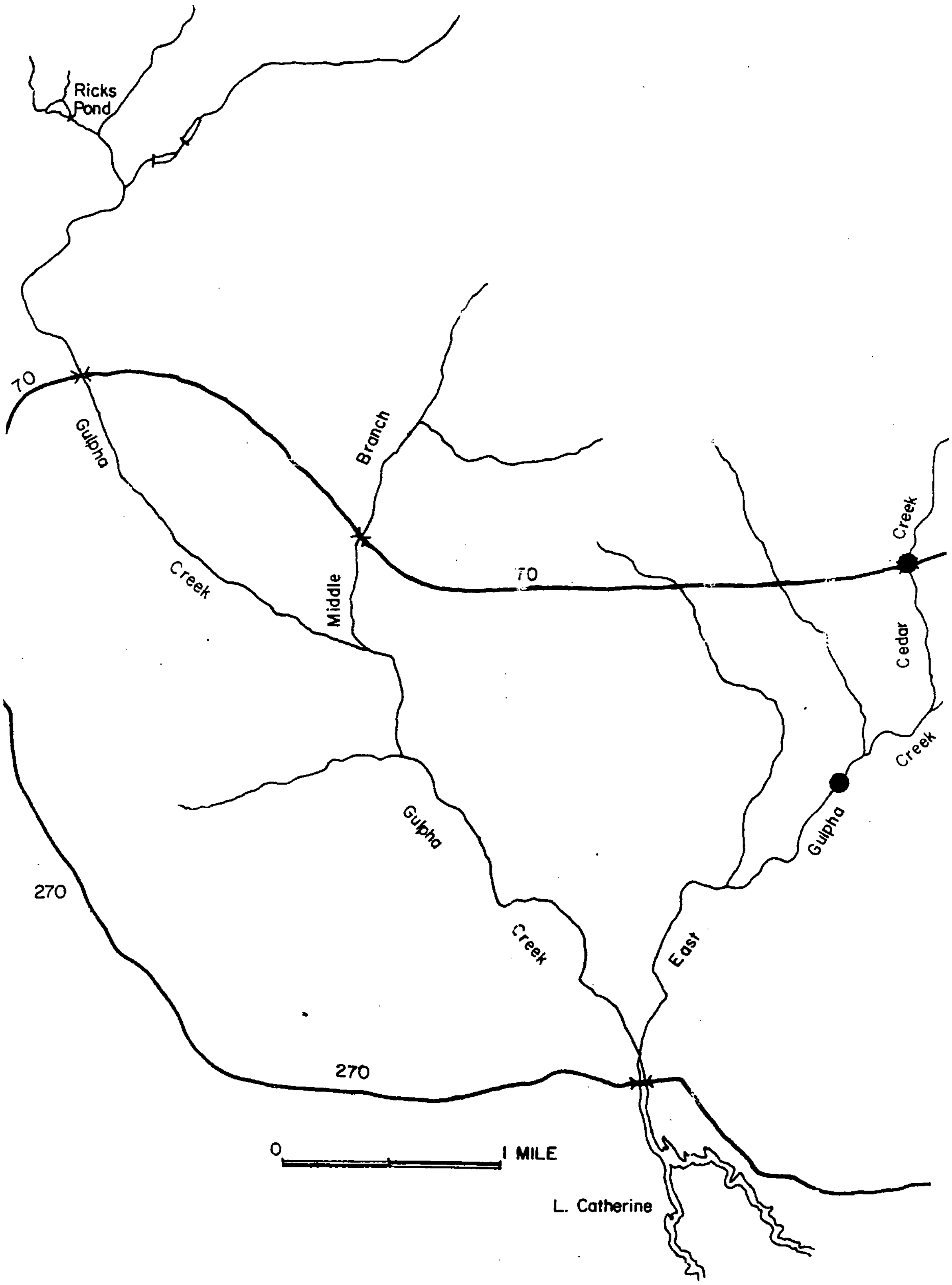


Figure 24 - Distribution map for the northern studfish, <u>Fundulus catenatus</u>.

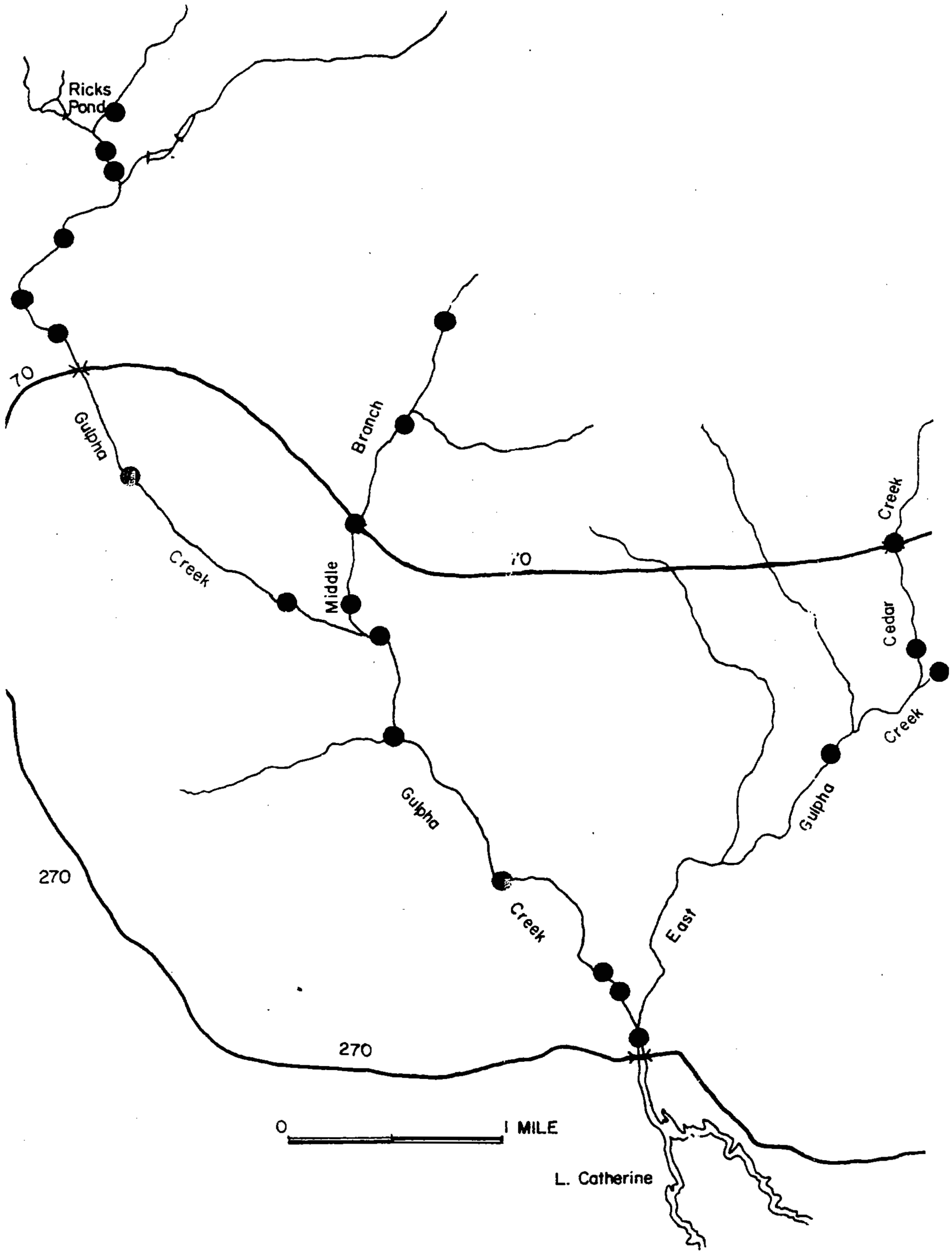


Figure 25 - Distribution map for the blackspotted topminnow, Fundulus olivaceus.

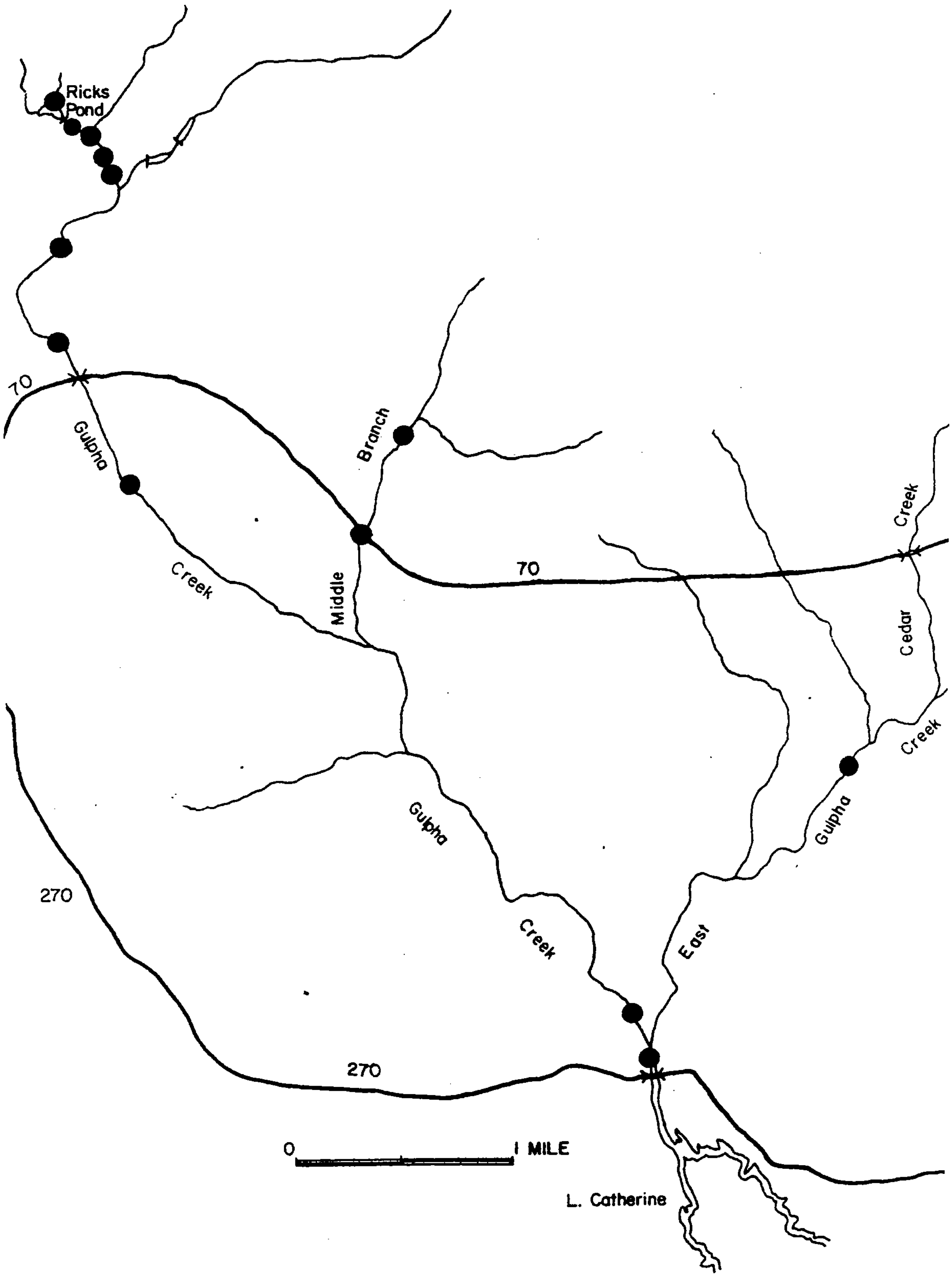


Figure 26 - Distribution map for the mosquitofish, Gambusia affinis.

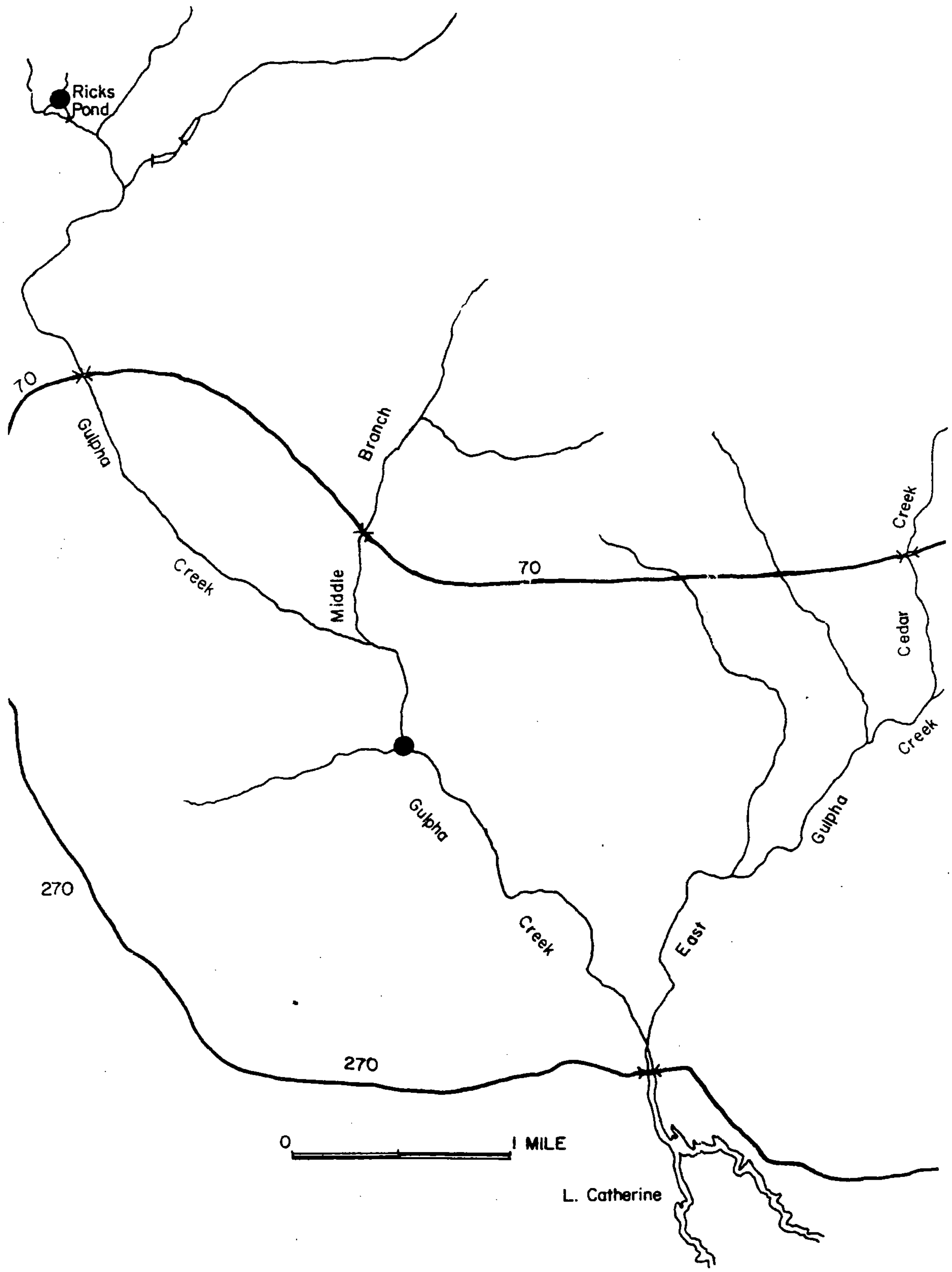


Figure 27 - Distribution map for the brook silverside, _Labidesthes sicculus_.

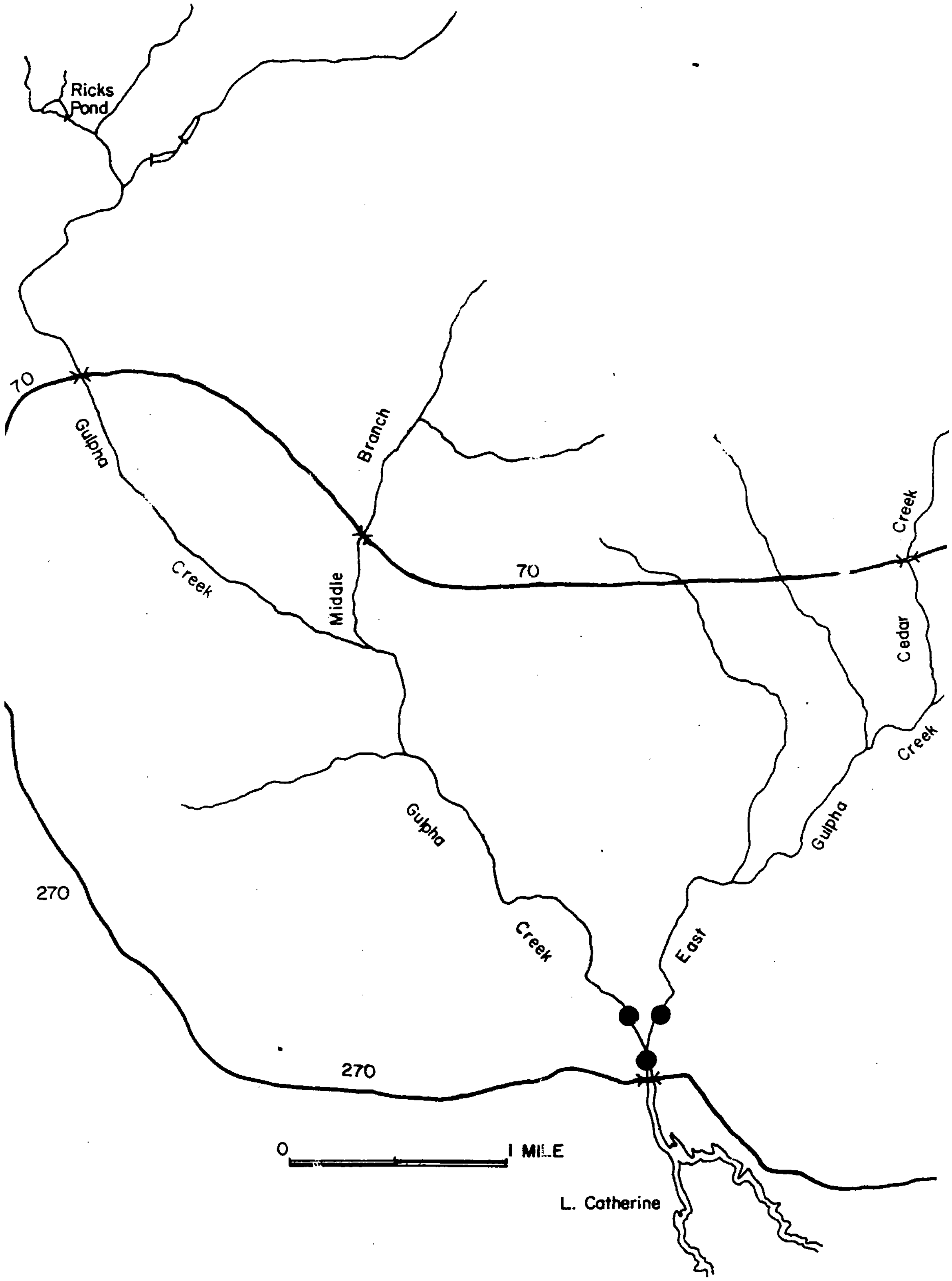


Figure 28 - Distribution map for the green sunfish, Lepomis cyanellus.

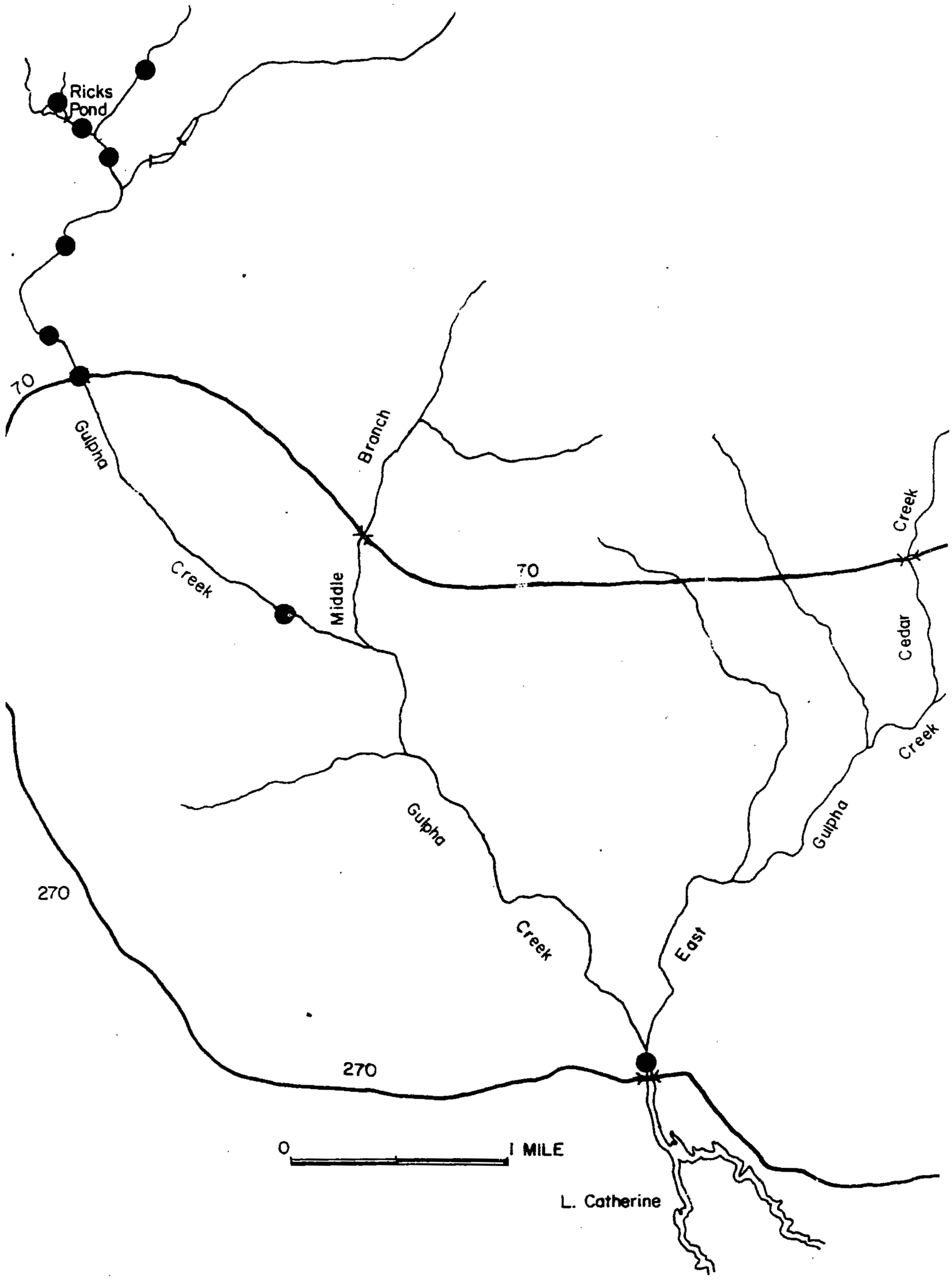


Figure 29 - Distribution map for the bluegill, Lepomis macrochirus.

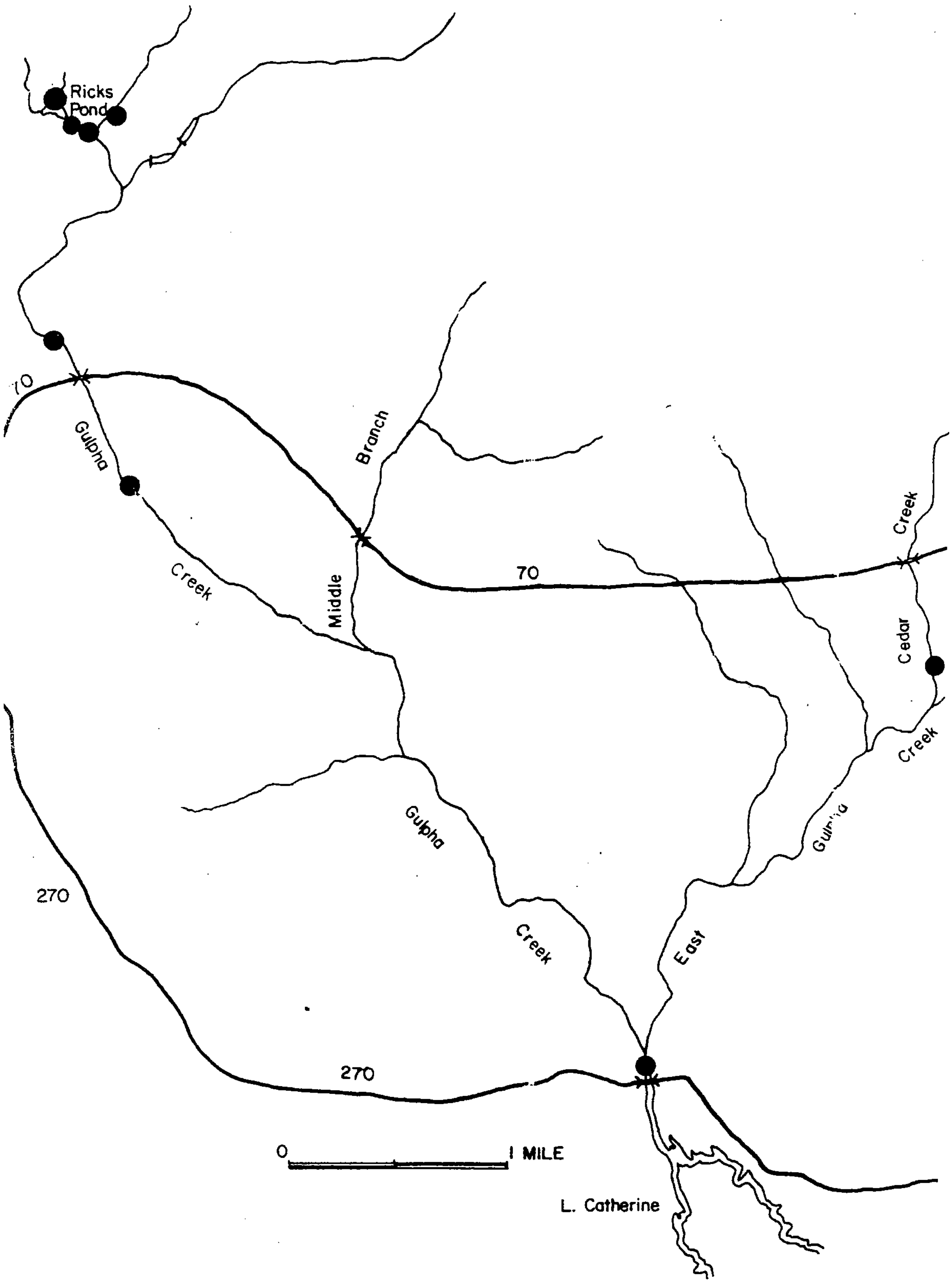


Figure 30 - Distribution map for the longear sunfish, Lepomis megalotis.

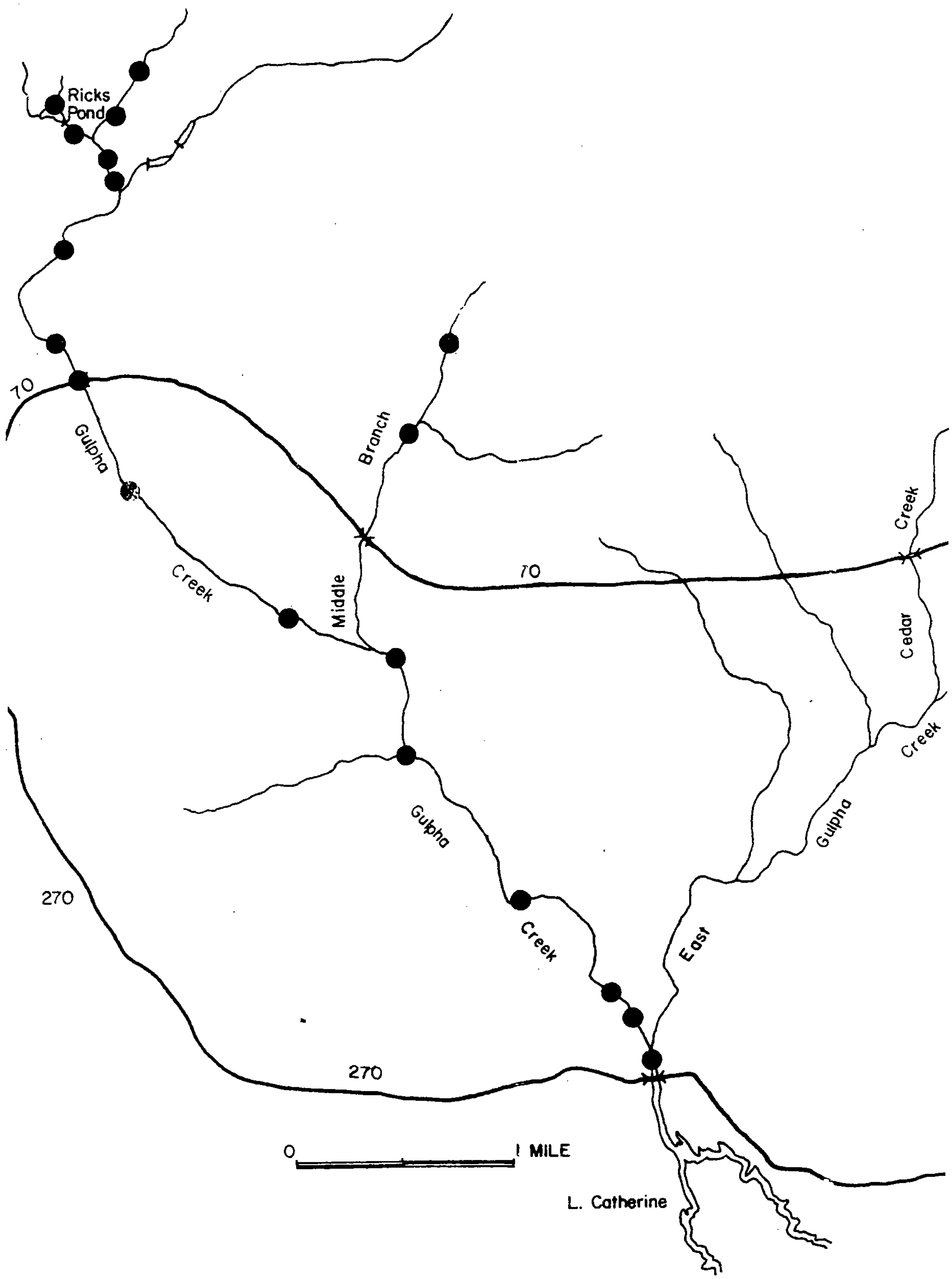


Figure 31 - Distribution map for the green sunfish x bluegill hybrid, Lepomis cyanellus x L. macrochirus.

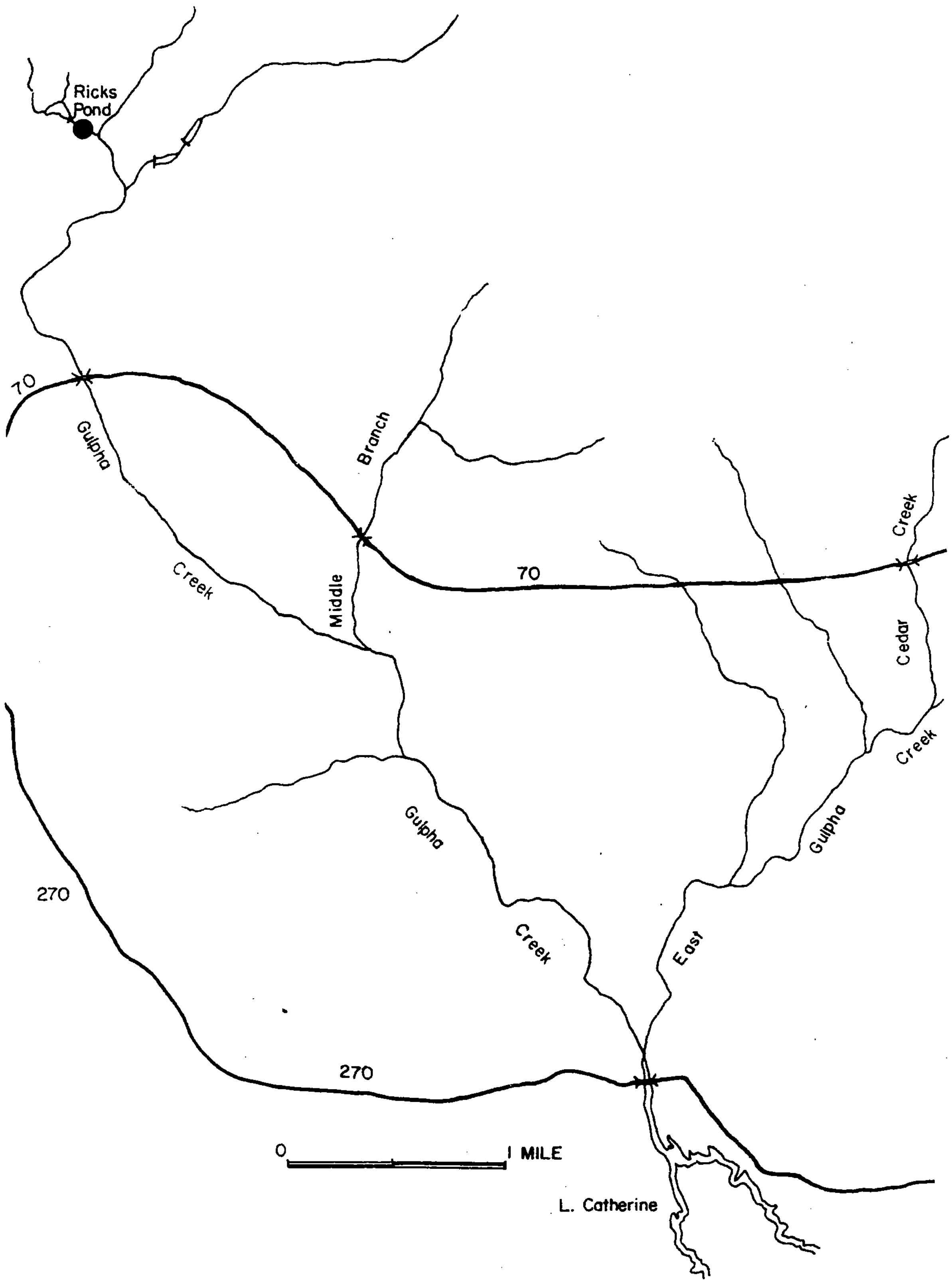


Figure 32 - Distribution map for the spotted bass, Micropterus punctulatus.

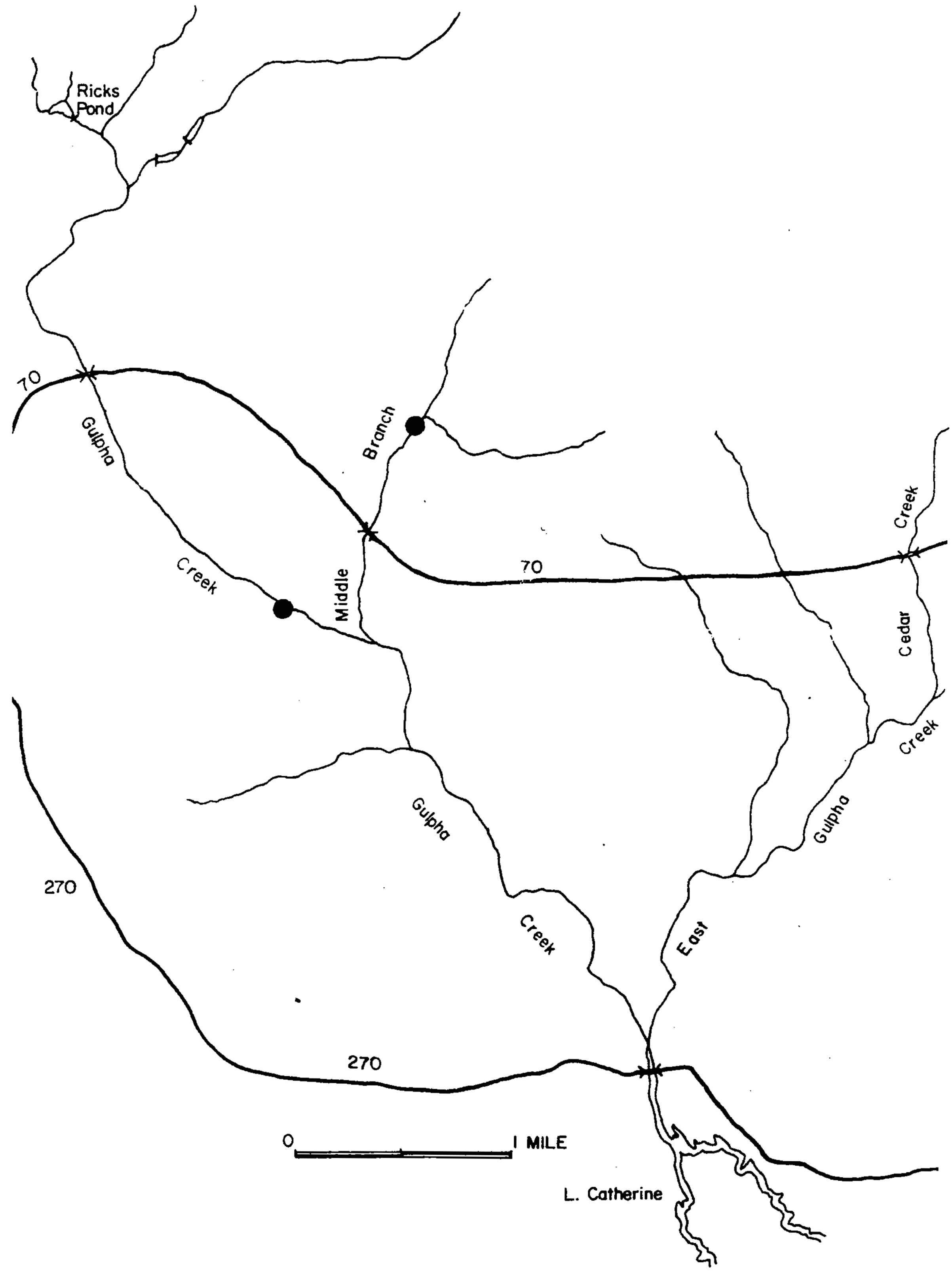


Figure 33 - Distribution map for the largemouth bass, Micropterus salmoides.

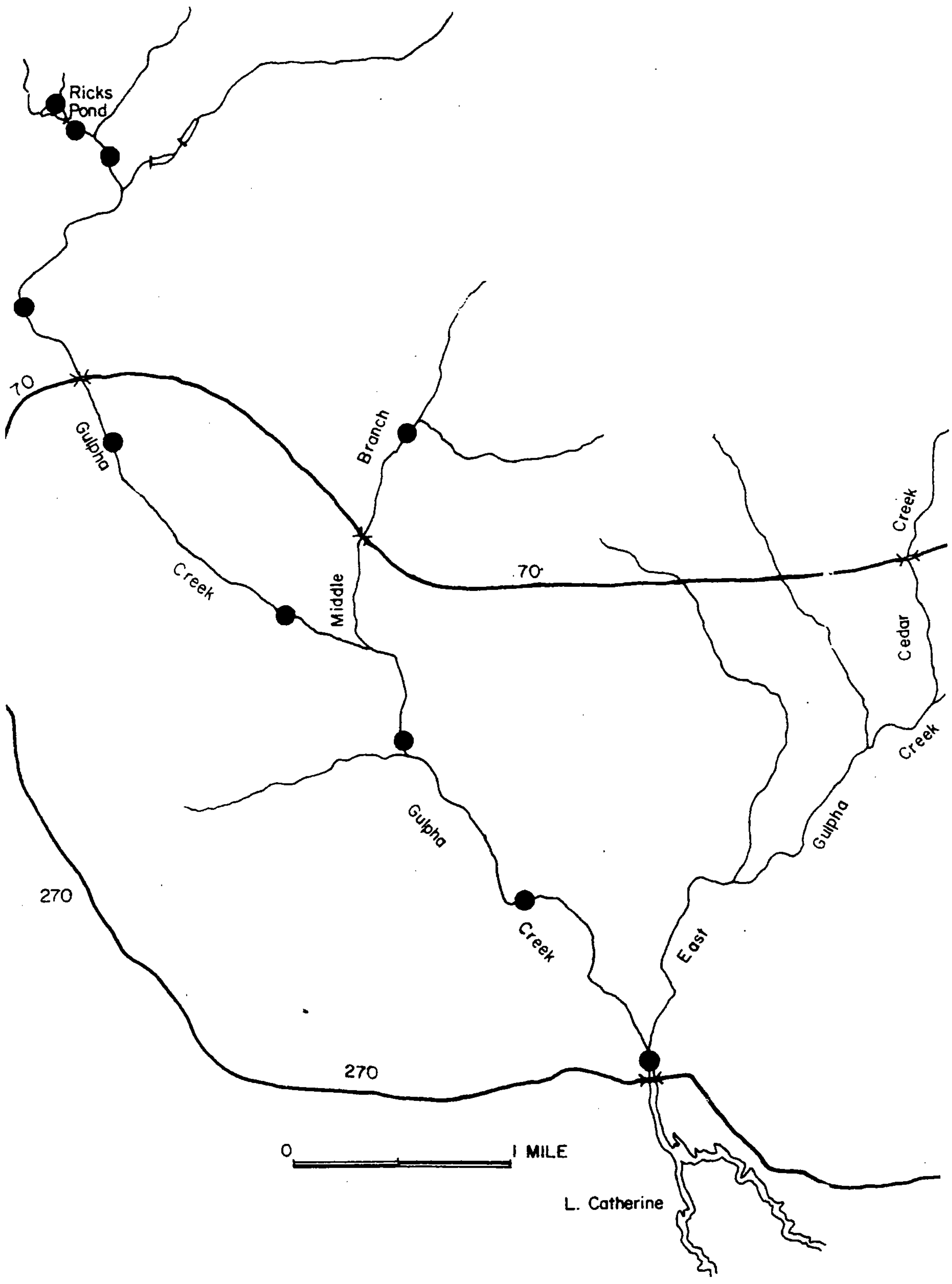


Figure 34 - Distribution map for the creole darter, Etheostoma collettei.

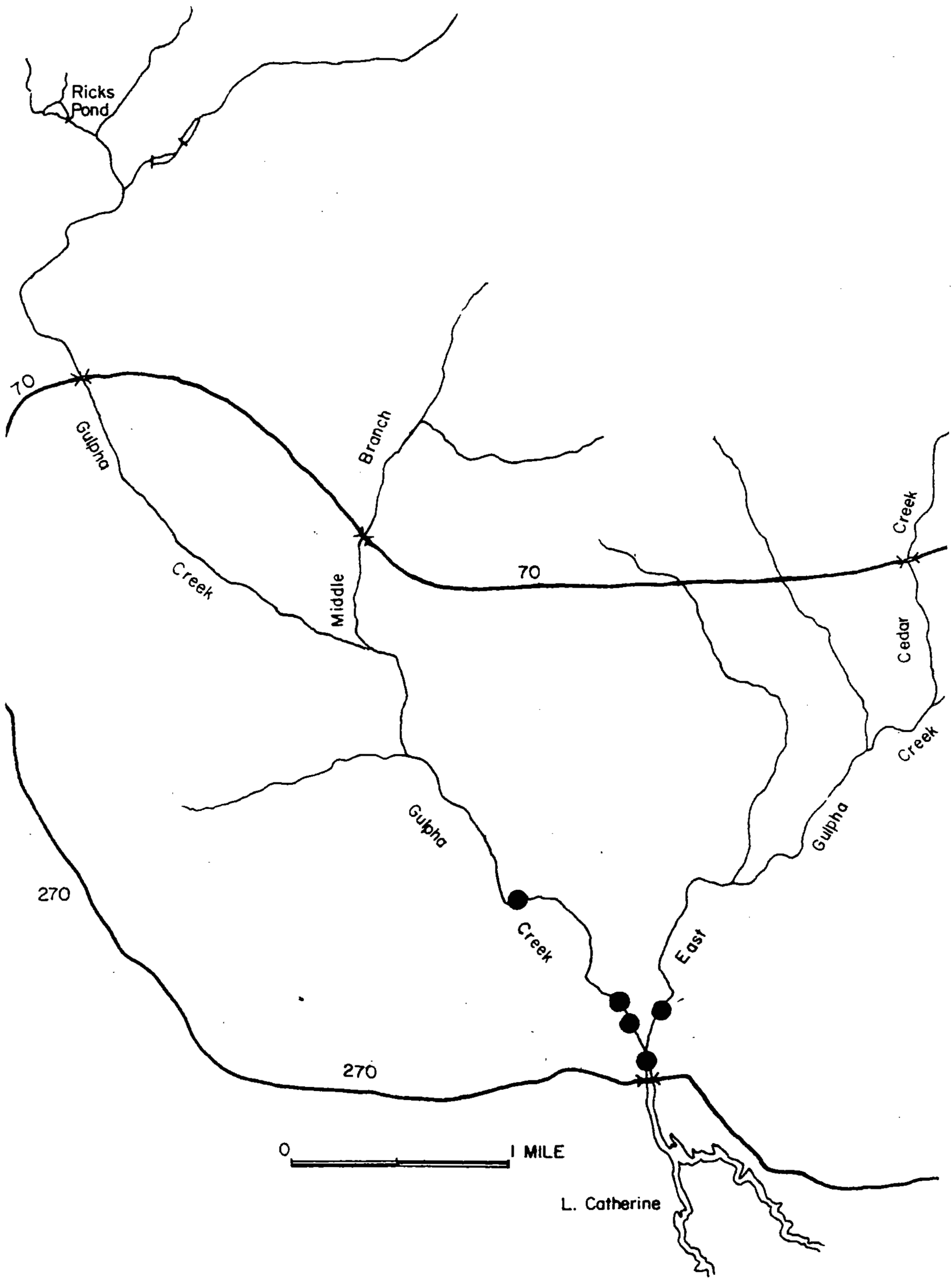
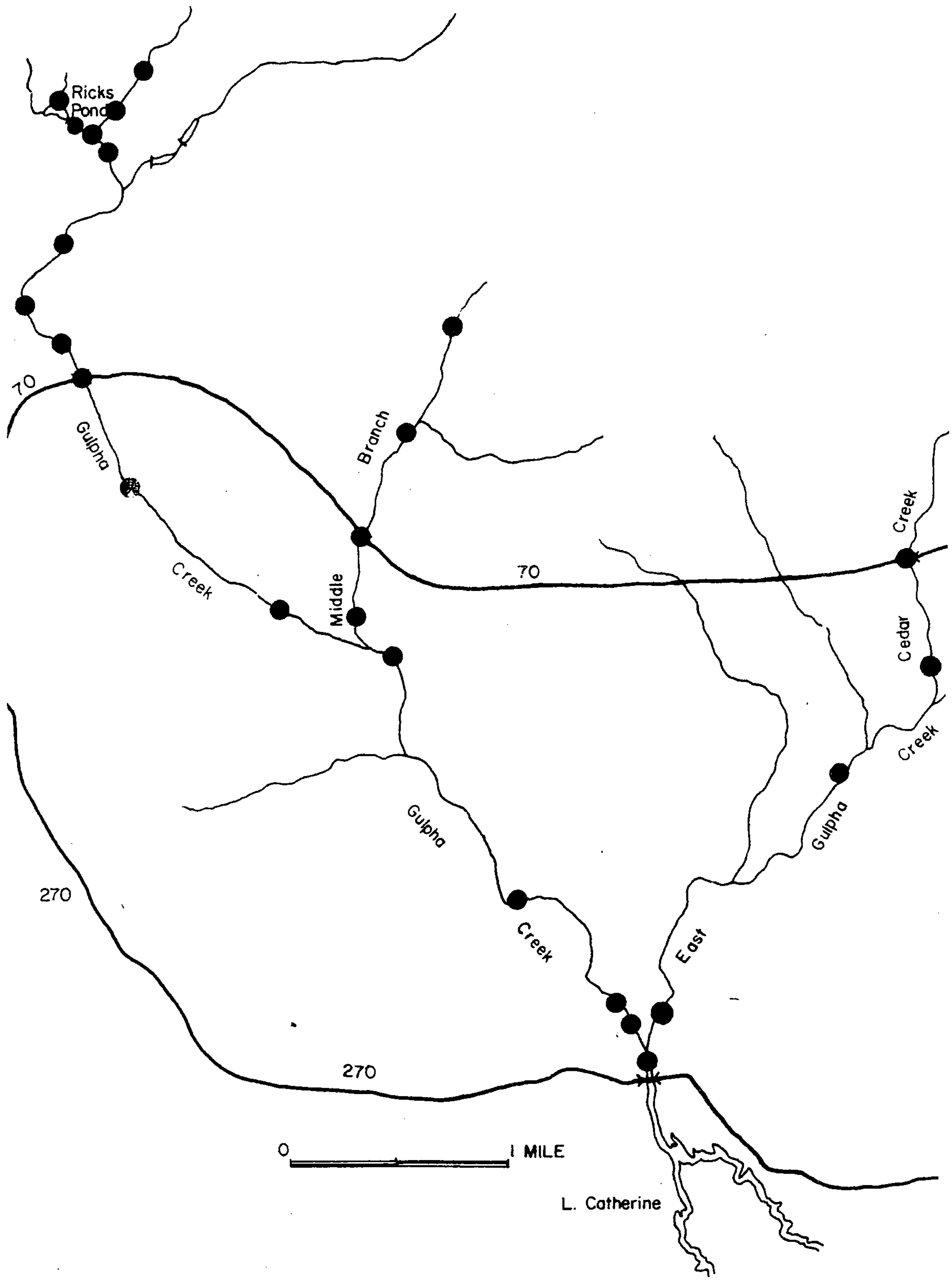


Figure 35 - Distribution map for the orangebelly darter, Etheostoma radiosum.



species (green sunfish X bluegill) were collected from the study area. No fish species collected from Ricks Pond or the Gulpha Creek drainage is on the federal list of rare and endangered species, and none is considered rare or endangered in Arkansas (Buchanan, 1974). In fact, all species except the creole darter, Etheostoma collettei, and the orange belly darter, Etheostoma radiosum, are broadly distributed over much of the state (Buchanan, 1973). The two darters, which are restricted to the Red and Ouachita River Basins, are nevertheless, widespread and abundant in streams of the Ouachita Mountains.

Annotated List of Fishes

The following annotated list of fishes from Ricks Pond and the Gulpha Creek drainage includes information about the relative abundance of each species as well as pertinent ecological data. The relative abundance of each species in the drainage system is described by one of the following categories:

(1) Rare - occurring at only one collecting site and represented by only one or a few individuals.

(2) Uncommon - occurring at only a few collecting sites (2-5), usually in one area of the drainage system, and represented by a few individuals at most.

(3) Common - occurring at several scattered collecting sites throughout a large portion of the drainage system.

(4) Abundant - occurring at 50% or more of the collecting sites in moderate numbers.

(5) Very Abundant - occurring at approximately 65% of the collecting sites, usually in large numbers.

Family Clupeidae - Herrings and Shads

1. Gizzard shad, *Dorosoma cepedianum* (Lesueur) (Figure 8)

Uncommon. This is primarily a fish of the larger streams and reservoirs, and was found only in the lower portion of Gulpha Creek near Lake Catherine, where the pools were larger. It avoids streams with very high gradients (Pflieger, 1975), such as the upper portion of the Gulpha Creek drainage. The adult shad are primarily filter feeders, utilizing particulate matter in the water.

Family Esocidae - Pikes

2. Grass pickerel, *Esox americanus* Lesueur (Figure 9)

Uncommon. This is the smallest species of the pike family, reaching only twelve inches in length and up to one pound in weight. It is most commonly found in small, clear creeks of the Ouachita Mountains and less commonly in Ozark Mountain streams. This species prefers heavily vegetated waters where it feeds on small fishes. The relative scarcity of higher aquatic vegetation along Gulpha Creek was probably a major cause of the scarcity of this species. Grass pickerels were collected only from a pool in Middle Branch, and near the mouth of Gulpha Creek. The two widespread collecting sites indicate that this fish probably occurs in small numbers in suitable habitat in other portions of the drainage.

Family Cyprinidae - Minnows and Carps

3. Stoneroller, *Campostoma anomalum* (Rafinesque) (Figure 10)

Very abundant. This species is a common inhabitant of small, clear, gravel bottomed streams and headwater creeks of the Ozark and Ouachita Mountains, but it is also moderately tolerant of siltation and turbidity (Cross, 1967). This minnow feeds on algae which it scrapes from rocks with its chisel-like lower jaw. Stonerollers were found throughout all but the coolest, spring-fed tributaries of Gulpha Creek, and were quite numerous at most localities in both riffles and pools. This species is undoubtedly one of the most important forage fishes in Gulpha Creek, providing food for predatory species.

4. Carp, Cyprinus carpio Linnaeus (Figure 11)

Rare. Carp were found only in Ricks Pond, where they were stocked by the previous owners for vegetation control. This species has many undesirable qualities such as competing for food and space with more desirable fishes, an important consideration in a small impoundment like Ricks Pond. Feeding habits of carp can result in a deterioration of the habitat through increased trubidity and the destruction of aquatic vegetation; they have also been reported to eat eggs of other species (Pflieger, 1975). A portion of the turbidity in Ricks Pond can probably be attributed to the bottom-stirring activities of carp. Carp were absent from Gulpha Creek itself; they typically prefer larger streams of lower gradient.

5. Golden shiner, Notemigonus crysoleucas (Mitchill) (Figure 12)

Rare. This common bait minnow was collected at only one locality where it was probably a bait release. A low-water dam was present at this collecting site, and children were observed fishing there on several occasions. The Arkansas Game and Fish Commission has periodically stocked bluegill sunfish there. The golden shiner is typically found in quiet, clear backwater areas and lakes having abundant vegetation, but it is somewhat tolerant of turbidity (Trautman, 1957).

6. Bigeye shiner, Notropis boops Gilbert (Figure 13)

Abundant. This minnow was widespread throughout the Gulpha Creek drainage except for the extreme headwaters (it avoids waters that are continuously cool). It is typically a fish of clear upland streams with high gradients, where it inhabits silt-free pools, usually with dense growths of filamentous algae. This species was most abundant in the larger downstream pools of Gulpha Creek.

7. Striped shiner, Notropis chrysocephalus (Rafinesque) (Figure 14)

Common. The distribution of the striped shiner in Gulpha Creek paralleled that of the bigeye shiner, a species with which it is commonly associated over much of its range. The striped shiner is usually found in clear, permanent-flowing streams with clean gravelly or rocky bottoms. It was most numerous in Middle Branch and East Gulpha Creek, where 3-5 inch individuals were common.

8. Redfin shiner, Notropis umbratilis (Girard) (Figure 15)

Common. This minnow was numerous in Middle Branch and East Gulpha Creek, but was collected from the main Gulpha Creek only near its mouth. It probably does occur elsewhere in the main creek, because it is a species that is known to occur in a variety of habitats in Arkansas.

9. Bluntnose minnow, Pimephales notatus (Rafinesque) (Figure 16)

Uncommon. This species is usually abundant in clear streams of moderate gradient, but only a few specimens were taken from four localities in the Gulpha Creek drainage. It is fairly tolerant of turbidity and is found in a variety of habitats in the state.

10. Creek chub, Semotilus atromaculatus (Mitchill) (Figure 17)

Uncommon. This minnow was found only in two small, cool, spring-fed tributaries in the extreme headwaters of Gulpha Creek. It is a species that is typically most abundant in this type of habitat where few other fish species are present.

Family Catostomidae - Suckers

11. Northern hog sucker, Hypentelium nigricans (Lesueur) (Figure 18)

Common. This species, which usually attains a length of 10-15 inches, was found throughout the study area, except for East Gulpha Creek, and it almost certainly occurs there as well. The hog sucker inhabits streams having clear water, gravel or rocky bottoms, and permanent flow. It feeds on aquatic insects and other bottom life by overturning rocks and stirring up the bottom with its fleshy, sucking lips. It is intolerant of turbidity and is rarely caught by hook-and-line fishing.

12. Golden redhorse, Moxostoma erythrurum (Rafinesque) (Figure 19)

Rare. This is often the most common redhorse sucker in small creeks of the Ouachita Mountains, however, it was collected only from one large pool in Middle Branch. This sucker prefers warmwater creeks with little current, and is fairly tolerant of turbidity and intermittent flow. It attains a length of 10-15 inches and feeds on benthic organisms.

Family Ictaluridae - Freshwater Catfishes

13. Black bullhead, Ictalurus melas (Rafinesque) (Figure 20)

Uncommon. This catfish was found at one locality in the extreme headwaters and two localities near the mouth of Gulpha Creek. Because it occurred at these widely separated sites, it probably occurs in small numbers elsewhere in the drainage. This species is known to occur in a wide variety of habitats, but prefers turbid water and silty bottoms; therefore, it is not common in the clear waters of Gulpha Creek. It can attain a length of 16 inches and a weight of over 2 pounds, and it feeds on a wide variety of animal and plant material.

14. Yellow bullhead, Ictalurus natalis (lesueur) (Figure 21)

Uncommon. This catfish prefers clearer water than the black bullhead and was found in Ricks Pond, Middle Branch, and the East Gulpha Creek drainage. It was not found in the main Gulpha Creek, but probably occurs there in very small numbers in vegetated areas. It is tolerant of different habitat types and is probably the most common bullhead in Arkansas, attaining a size slightly larger than the black bullhead. The two bullheads do not attain a large enough size in the Gulpha Creek drainage to be of angling importance.

15. Channel catfish, Ictalurus punctatus (Rafinesque) (Figure 22)

Rare. This is one of the most highly prized game and food fishes in Arkansas. It was found only in Ricks Pond where it had been stocked. It is probably found in Gulpha Creek only during periods of high water. This catfish occurs in a variety of habitats over its range, but prefers large rivers of low gradient and also manmade impoundments. The largest Ricks Pond specimen weighed five pounds. The channel catfish feeds on a large variety of items including fishes, invertebrates, and dead organic matter. This species can be easily cultured in small impoundments such as Ricks Pond.

16. Tadpole madtom, *Noturus gyrinus* (Mitchill) (Figure 23)

Uncommon. This is a small catfish species attaining a maximum size of about four inches. It was found only at two localities in the East Gulpha Creek drainage despite substantial efforts to locate it (and other catfishes) throughout the Gulpha Creek drainage system. In Arkansas, the tadpole madtom occurs in a variety of habitats from clear to moderately turbid waters having little current, but with an abundance of cover such as aquatic vegetation. It feeds primarily on insect larvae and other small benthic organisms.

Family Cyprinodontidae - Killifishes

17. Northern studfish, *Fundulus catenatus* (Storer) (Figure 24)

Very Abundant. This small (3-6 inches) minnow-like species was found in great numbers throughout the study area. It prefers streams of small to moderate size with high gradients, permanent flows, clear water, and silt-free bottoms of gravel and bedrock. It feeds on a wide variety of stream invertebrates.

18. Blackspotted topminnow, *Fundulus olivaceus* (Storer) (Figure 25)

Common. This species was also widely distributed throughout the study area, but was not nearly as numerous as its relative, the northern studfish. It is a small fish (2-4 inches) that feeds with its upward-tilted mouth at the water's surface primarily on small invertebrates. It prefers quieter waters than the studfish.

Family Poeciliidae - Livebearers

19. Mosquitofish, *Gambusia affinis* (Baird and Girard) (Figure 26)

Uncommon. This small (1-2 inches) species was found only in Ricks Pond and at one locality in Gulpha Creek. It is most common near the surface of the shallowest backwaters and quiet pools where it feeds on insects, larvae, and zooplankton. It has been widely stocked in the United States as a biological control for mosquitoes. This is the only fish native to Arkansas that has internal fertilization and gives birth to its young, rather than laying eggs.

Family Atherinidae - Silversides

20. Brook silverside, *Labidesthes sicculus* (Cope) (Figure 27)

Uncommon. This species is usually common in the clear, quiet pools of Ouachita Mountain headwater streams, but was found only near the mouths of Gulpha and East Gulpha Creeks. This 2-4 inch fish remains near the water's surface where it feeds primarily on insects.

Family Centrarchidae - Sunfishes

21. Green sunfish, *Lepomis cyanellus* Rafinesque (Figure 28)

Common. This species is often the most important gamefish in small intermittent creeks that are incapable of supporting most other kinds of hook-and-line fish (Pflieger, 1975). It tolerates a wide range of conditions and does best where few other sunfishes occur. It was widely distributed throughout Gulpha Creek and Ricks Pond, but it was most numerous in the pond where several large individuals were collected. Green sunfish feed primarily on small fish and crayfish.

22. Bullgill, *Lepomis macrochirus* Rafinesque (Figure 29)

Common. This was the most abundant gamefish in Ricks Pond where it has been stocked. It occurred sporadically at other localities in the Gulpha Creek drainage. It has been widely stocked in Arkansas by the state Game and Fish Commission, because it thrives in manmade impoundments. The bluegill tends to become overcrowded in ponds where predation is low, resulting in stunted growth. This seemed to be the situation in Ricks Pond, and it would be difficult to establish a satisfactory bluegill fishery there. This species is intolerant of continuous high turbidity and siltation and prefers vegetated areas for cover.

23. Longear sunfish, Lepomis megalotis (Rafinesque) (Figure 30)

Very Abundant. This was the most common sunfish throughout the Gulpha Creek drainage, but it occurred in only small numbers in Ricks Pond. It is primarily a stream fish, but avoids strong current and does not attain the size of the other sunfishes in the study area. Insects and other small invertebrates make up most of its diet.

24. Green sunfish x Bluegill Hybrid (Lepomis cyanellus x L. macrochirus) (Figure 31)

Rare. This hybrid between two of the sunfishes was found only in Gulpha Creek just downstream from the Ricks Pond dam. This is a fairly common type of sunfish hybrid, and several specimens were taken.

25. Spotted bass, Micropterus punctulatus (Rafinesque) (Figure 32)

Uncommon. This game species was found only in Middle Branch and in Gulpha Creek near its confluence with Middle Branch. It is generally most abundant in permanently flowing streams somewhat larger than Gulpha Creek, and did not occur commonly in that drainage. It prefers areas of moderate gradient, clear, flowing waters, and a minimum of siltation; this bass basically avoids headwater streams.

26. Largemouth bass, Micropterus salmoides (Lacepede) (Figure 33)

Common. The largemouth bass, one of the most important game species, was found throughout the study area, including Ricks Pond. Although Gulpha Creek is not suitable habitat for the production of large individuals, a few 1-2 pound specimens were observed in some of the downstream pools. It has been stocked in Ricks Pond and numerous young-of-the-year bass were collected there. Corss (1967) described the largemouth bass as an "obligate carnivore." This fact limits the poundage of bass that any body of water can support. Bass eat a variety of living organisms, but bass production cannot be substantially increased by the addition of supplemental food. They differ in this respect from most kinds of catfish and trout which readily accept artificial diets. The average standing crop of bass is considerably less than 100 pounds per acre, even in good bass lakes (Cross, 1967). Therefore, small impoundments such as Ricks Pond cannot reasonably be expected to yield numerous "catchable" bass for anglers throughout the year, and catchable size bass are not available commercially for establishing a put-and-take fishery for them in Ricks Pond.

Family Percidae - Perches

27. Creole darter, *Etheostoma collettei* (Birdsong and Knapp) (Figure 34)

Uncommon. This small (2 inches) colorful member of the perch family is endemic to the Ouachita River Basin of Arkansas and Louisiana, where it is abundant in clear creeks having a gravel bottom and some aquatic vegetation, but has been found in a variety of habitat types. It was found only in the lower portion of the Gulpha Creek drainage within one mile of Lake Catherine.

28. Orangebelly darter, Etheostoma radiosum (Hubbs and Black) (Figure 35)

Very Abundant. This colorful darter was found at more localities than any other species. It was most abundant in the shallow, gravel bottomed riffles where it fed on invertebrates. It was also found in the pools in smaller numbers and was even taken from Ricks Pond. This species is endemic to the Red and Ouachita River drainages of southeastern Oklahoma and southern Arkansas.

RECOMMENDATIONS FOR THE ESTABLISHMENT OF A PUT-AND-TAKE FISHERY IN RICKS POND

Ricks Pond is best-suited for the establishment of a put-and-take fishery for channel catfish, Ictalurus punctatus. Two other commonly stocked species, the largemouth bass (Micropterus salmoides) and the bluegill (Lepomis macrochirus) are not suited for this location. Sufficient numbers of catchable bass are not available, and the bluegill tends to become overcrowded and stunted in this type of environment. Channel catfish should do well in Ricks Pond, and they are commercially available in catchable sizes for establishing a one species fishery.

In larger impoundments it is usually desirable to attempt to establish a balanced, self-reproducing, mixed species fish community. This would be undesirable, if not impossible, in Ricks Pond, because it is subject to periodic flash flooding and flushing. Occasional heavy rainfall, which sometimes occurs in the Hot Springs area, would wash many of the fishes downstream through Gulpha Creek. This is a common problem of small impoundments located on high gradient headwater streams in Arkansas (pers. Comm., William E. Keith, Chief of Fisheries, Arkansas Game and Fish Commission).

The following recommendations are made for the establishment of a put-and-take fishery for channel catfish:

1. Renovation of the pond by draining and deepening it.

Ricks Pond has a drain valve at the bottom of the dam. Draining the pond would allow removal of the undesirable carp and all other species. The dam is approximately six meters high, but the maximum pond depth was three meters, and the pond was very shallow overall (Figure 2). Ricks Pond was last drained and deepened about

40 years ago (pers. comm., former owner) and since then much siltation has occurred. The land surrounding the pond is wooded (primarily with deciduous trees such as sweet gum, maples, oaks, and hickory) and the annual fall of leaves and twigs has contributed significantly to the accumulation of detritus on the pond bottom. Restoring the pond to its original maximum depth would permit it to support a larger catfish population, and would probably reduce the impact of flushing during heavy rains.

2. Removal of the sewer line from the pond.

As noted in a previous section of this report, there is a Hot Springs city sewer line running through the pond near the north bank. The two manholes which emerge from the surface of the pond have only a 10 cm clearance (distance between the surface of the pond and the top of the manholes). This sewer line serves only six domestic units (pers. comm., Hot Springs City Engineer), and water supposedly flows into the manholes during periods of high water, rather than discharging raw sewage into the pond and stream system. Even if this is correct, the mere presence of a sewer line and two manholes in a body of water that is being used by the public should be viewed with caution. If at all possible, consideration should be given to sewering the small number of domestic units by some other route and abandoning the line which goes through the pond. This would eliminate the real possibility of a freak introduction of sewage into a system used by the public. A qualified engineer could possibly offer an alternate solution to this problem.

3. Stocking of channel catfish.

Ricks Pond should adequately be able to support approximately

300 pounds per acre of catchable catfish (8-10 inch fish) on the natural foods present. Therefore, the entire pond should naturally support around 740 pounds of catfish, because it appeared (from the water quality and plankton data) to be a moderately productive ecosystem. The frequency of stocking needed to maintain this population level would be determined by the amount of fishing pressure the pond received. If the pond is deepened, its production limit could rise to around 400 pounds per acre.

Channel catfish readily accept artificial diets of pelleted food. With supplemental feeding of three per cent of the total fish biomass per day, six days a week during the growing season of 210 days in Arkansas (Gray, 1976), Ricks Pond could easily support in excess of 1,000 pounds of channel catfish per acre. However, there would be drawbacks to such a feeding program, aside from its cost. Periods of low oxygen in late summer could be enhanced by the addition of the nutrients in the food. Nitrogen appeared to be the main limiting factor for productivity in the pond (Tables 2, 4, and 6). The addition of nitrogen to the pond (in the food) could stimulate an algae "bloom" which would lead to an oxygen depletion, causing a fish kill. Therefore, it is probably most desirable to stock Ricks Pond with the amount of catfish biomass that can be naturally supported.

4. <u>Periodic monitoring of water quality.</u>

The water quality of Ricks Pond should be checked periodically to detect any changes in conditions, particularly those induced by man's activities.

SUMMARY

A limnological investigation of Ricks Pond and the Gulpha Creek drainage of Garland County, Arkansas was conducted between 1 June 1978, and 21 August 1978. Water samples taken from ten stations on three different dates indicated that the stream and pond systems were typical in water quality characteristics of other small, high gradient streams and impoundments in the Ouachita Mountains of Arkansas. In Ricks Pond, thermal stratification occurred along with the development of an oxygen deficient zone below a depth of one meter. Other water quality parameters indicated that Ricks Pond is a moderately productive ecosystem, with the productivity limited by the nitrogen species.

The fecal coliform bacterial counts were very low, indicating no direct input of excessive amounts of fecal matter into the system during the present study. However, a Hot Springs city sewer line runs through the pond, and two manholes emerge from the pond's surface. The possibility exists that this sewer line could discharge raw sewage into Ricks Pond during periods of high water.

A biological investigation was also conducted in the study area, and lists of the phytoplankton, periphyton, higher aquatic vegetation, zooplankton, benthic macroinvertebrates, and fishes are presented. Twenty-seven species of fishes were collected from the Gulpha Creek drainage, and no rare or endangered forms were found.

Ricks Pond is best-suited for the establishment of a put-and-take fishery for channel catfish, Ictalurus punctatus. The following recommendations were made for the establishment of such a fishery: (1) Renovation of the pond by draining and deepening it; (2) Removal of the sewer line from the pond; (3) Stocking of

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catchable size channel catfish at the rate of approximately 300-400 pounds per acre; and (4) Periodic monitoring of the water quality.

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